ENGINEERING NEWS-RECORD

MAY 22, 1941

Jigs for prefabricating house sections in assembly line process for a FWA defense housing project

St. Lawrence Development

New light on what is proposed and its significance in the present emergency

A Staff Report by

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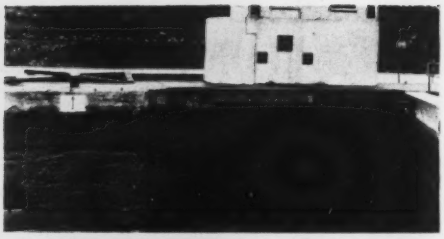
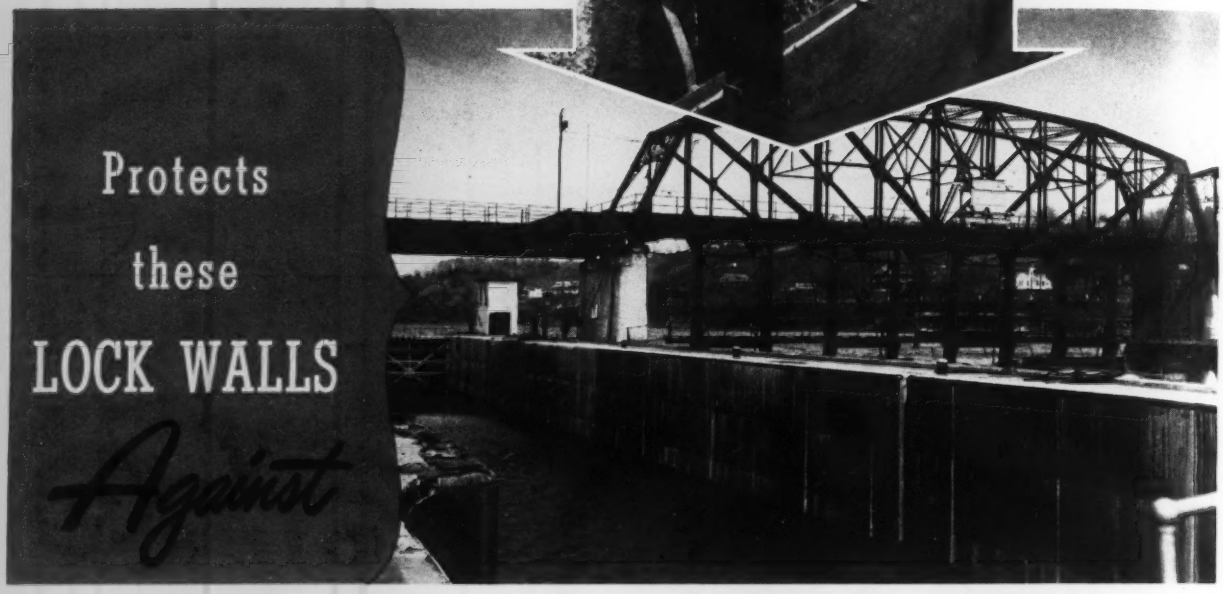
BYERS WROUGHT IRON



LOCK WALL BEFORE CHIPPING

DETAIL OF APPLICATION OF WROUGHT IRON PLATES



CORROSION . . . EROSION . . . MECHANICAL FAILURE

The war to prevent deterioration of lock walls must be fought on several fronts. The chemical and erosive action of the water itself, the alternate wetting and drying of sections of the wall, and mechanical damage from floating debris, ice, boats or barges, combine to make service conditions unusually severe, and bring vexing problems to maintenance personnel.

When these conditions caused serious deterioration of the walls of Lock No. 10, Cranesville, N.Y., the engineers faced the wall with wrought iron plates. Six to eight inches of the wall facing was chipped away, to remove "rotten" material. Bolts were inserted, butt-straps installed, and the plates applied. The three illustrations above show various stages of the work.

A similar situation was encountered in 1935, in Lock No. 24 at Baldwinsville, N. Y. Several repair methods were investigated. Wrought iron plates were used. Two successive reports have quoted the engineers as being well satisfied. The work on Lock No. 10 was under the direction of Mr. Guy W. Pinck, now Commissioner, New York State Department of Barge Canals, who formerly as District Engineer had designed the Lock No. 24 job.

If you have any problem involving the protection or repair of lock walls, or any submerged structure exposed to similar service conditions, we suggest that you give some thought to the advantages of using wrought iron. Its service qualities have been demonstrated over periods of many years. Some of the many records are given in our bulletin, "Wrought Iron in Salt Water Services," and others are on file in our Engineering Service Department. When considering the suitability of wrought iron, it is worth remembering that we are in a position to make prompt deliveries on all wrought iron products, including pipe, plates, bars and standard-size shapes, all of which are listed in our General Catalog. The Bulletin, the Catalog, or both, will be sent on request.

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Vol. 126 May 22, 1941 No. 21

THIS WEEK

• Significant factors bearing on the St. Lawrence seaway and power project are presented in a 16-page review in which *Engineering News-Record* outlines the historic background, engineering and administrative aspects, and what is proposed.

• Differing from previous barrel shell roof designs, the Uline Ice Arena in Washington, D. C., has exterior ribs supporting the 132-ft. concrete span. The solution of construction problems, including the use of timber trusses and trestles, are reviewed.

• As an experiment in barracks construction, the Army built several out of steel, hollow tile and concrete at Camp Grant. The design of these units is described.

• Among current housing projects one at Audubon Village, N. J., is outstanding both in the extent of prefabrication procedure that was developed, and in the financing system, which may have broad applications. Both construction and financing are reviewed in a comprehensive treatment.

THINGS TO COME

• Additions of fats and resins to cement have been carefully studied in the laboratory of the Lone Star Cement Corp. and the results will be summarized, with supporting data in the June 5 issue.

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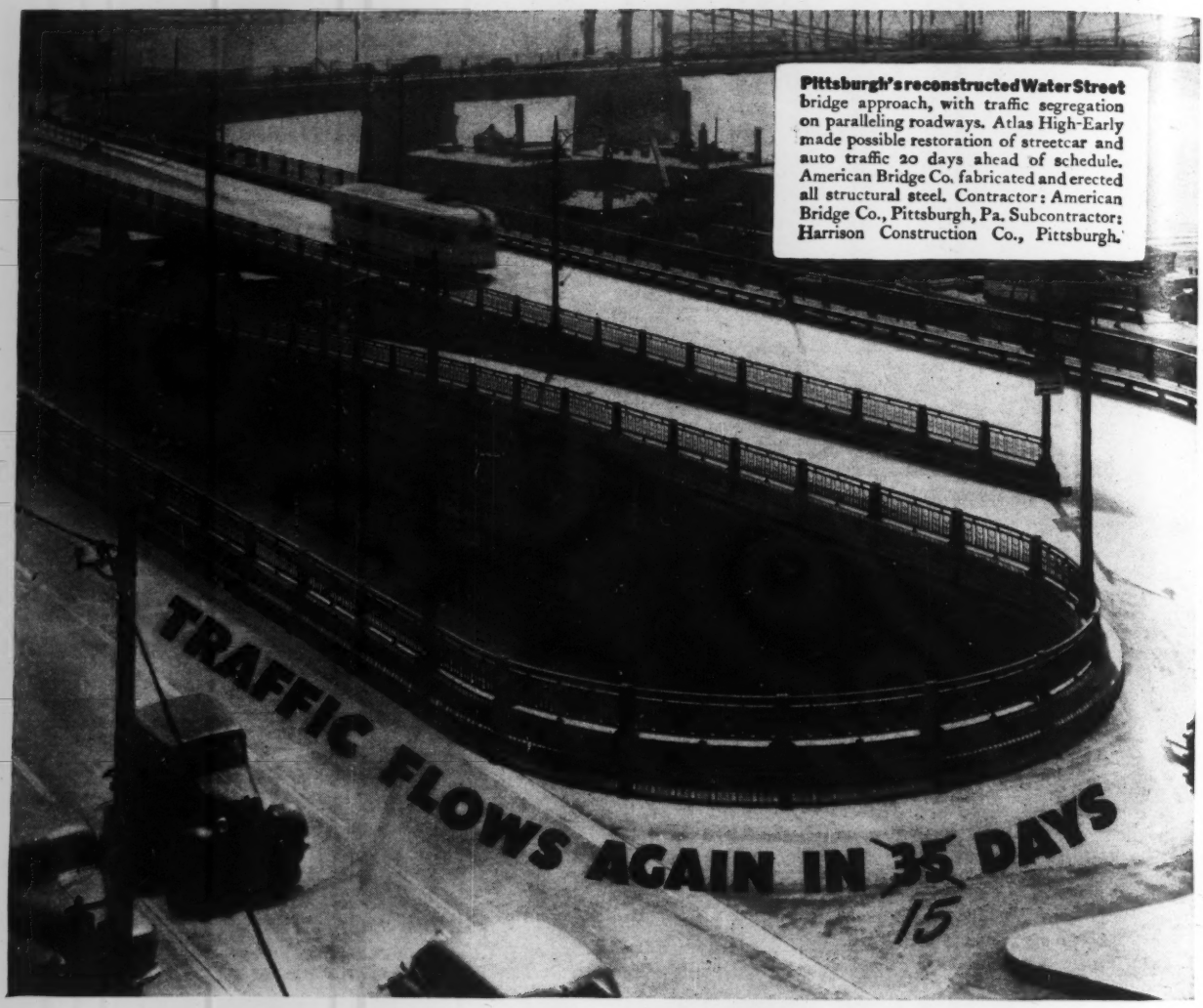

Pittsburgh's reconstructed Water Street bridge approach, with traffic segregation on paralleling roadways. Atlas High-Early made possible restoration of streetcar and auto traffic 20 days ahead of schedule. American Bridge Co. fabricated and erected all structural steel. Contractor: American Bridge Co., Pittsburgh, Pa. Subcontractor: Harrison Construction Co., Pittsburgh.

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A CONTRACTOR got an idea . . and knocked a normal street construction schedule into a cocked hat! He got traffic moving almost three weeks earlier on Pittsburgh's vital artery. The Water Street project was just under way when he saw that Atlas High-Early cement could cut concreting time more than half!

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NR-H-33

ATLAS HIGH-EARLY CEMENT

A UNIVERSAL ATLAS PRODUCT

FWA taking over defense housing under new agency

May supersede USHA and PBA completely on this class of work. It already controls nearly a quarter of all defense dwelling units.

Gradually, a new housing agency is being created to handle defense housing. It has received no publicity, doesn't even have a name, and so far has been assigned only about twenty of the nearly 300 defense housing jobs approved. However, the projects it has are big ones, so that nearly a quarter of the total number of dwelling units are under its control; and two-thirds of the most recently approved projects have gone to it.

The new agency consists of a housing staff directly attached to the Federal Works Agency rather than to one of the component agencies of FWA such as the U. S. Housing Authority or the Public Buildings Administration. It has a small Washington staff and two field offices, in Pittsburgh and Bridgeport, with staffs of about 30 men each.

This organization was built up partly as a recognition that defense housing has differing objectives and methods from slum clearance or post office construction and partly, doubtless, because Works Administrator Carmody wanted to get the rather slow-moving defense housing program directly under his control to speed up operations.

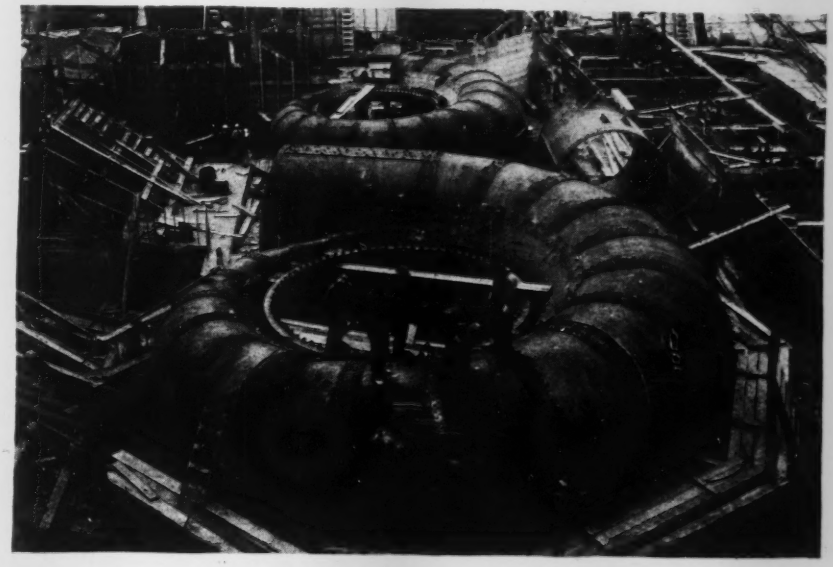
Prefabrication jobs taken over

First to be absorbed by FWA was prefabricated housing. Just about all of the newer projects of this type are being assigned to FWA. Public Buildings Administration, which originally was in charge of prefabrication, ran into difficulties in its negotiations with manufacturers. Biggest source of contention was the question of erection; PBA wanted this done by general contractors, while the manufacturers wanted to do it themselves. Also, it was generally believed that PBA was not overly sympathetic to the whole idea and, accustomed to dealing with AFL-organized contractors, was rather disturbed by the CIO cast of the prefabrication industry.

That PBA's fears were not entirely unjustified was indicated this week when AFL workmen walked out at the Indianhead, Md. "prefabrication laboratory" project in protest of employment of CIO workmen by two of the prefabricators—Home Building Corporation of Kansas City and Lockwall Houses of New York. A somewhat similar issue arose last month at Camden, N. J., when the AFL, which was erecting the houses, struck against CIO operations at the prefabricating plant; that strike was settled on the basis of permitting AFL to construct some of the houses by conventional methods.

Most of the early difficulties are believed now to have been ironed out in conferences between manufacturers and FWA. A policy has been arrived at by which manufacturers will do erection themselves—contracting to deliver a house ready for occupancy, generally in ninety days. Still being worked out is a plan by which manufacturers would simply contract to deliver houses, with the location not necessarily specified until manufacture is complete.

Heading up the FWA portion of the defense housing effort is Clark Foreman, formerly head of the power division of PWA. Reporting directly to Carmody, Foreman is responsible both for projects assigned to other agencies and for FWA direct operations. Assistant director of



Scroll cases for Fort Peck Dam turbines nearly complete

Rapid progress is being made by Woods Bros. Const. Co., Lincoln, Nebr., in building the substructure for the hydro-electric power plant at the outlet end of Tunnel No. 1 at Fort Peck Dam in Montana. As shown by the accompanying illustration, scroll cases for the two initial units are nearing completion. These are for 50,000 and 20,000-h.p. turbines being built by S. Morgan Smith Co. The Allis-Chalmers Mfg. Co. is furnishing 35,000 and 15,000-kw. generators for the initial units; the plant has an ultimate capacity of 105,000 kw. Installation of turbines, generators, butterfly valves and penstocks will be included in a contract for the plant superstructure, which will be advertised later this spring by the U. S. District Engineer.

defense housing is Sherwood Reeder, formerly at Federal Security Agency's Greenhills project.

Under Foreman, a section of direct operations is in charge of the non-prefabricated projects assigned directly to FWA. Headed by Talbot Wegg, brought from USHA, this section oversees the operations of the two field offices as well as of two local authorities at Akron and Cincinnati; due to a legal tangle, projects were assigned to these bodies without the intervention of USHA.

This section has been able to hold its staff down by a policy of using, on a cost basis, the facilities of local housing authorities wherever these are available and by retaining local architects and engineers.

Prefabricated housing is handled by another section headed by Ruf Newman, formerly a regional director for PWA. Under him is Allan Stevens, who has been brought over from PBA where he was the specialist on prefabrication.

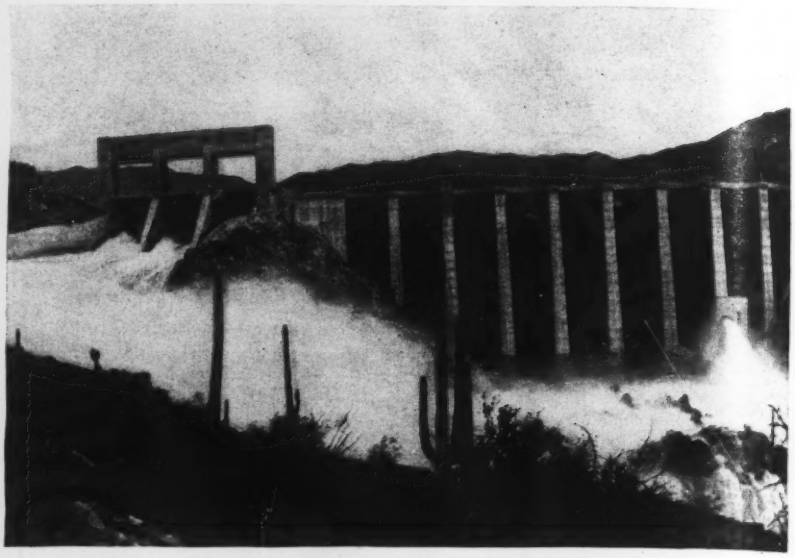
Both direct and indirect operations are dealt with by a section on utilities headed by Morris Miller, formerly of USHA, a land acquisition section under Tudor Morsell, and a review section, which studies plans from the management and maintenance viewpoint, headed by Kline Fulner.

• • •

Insurance rating plan for army contractors

Insurance carried by Army contractors and sub-contractors doing fee work is to be put on a cost-plus-fee basis under a new "insurance rating plan" developed by the War Department. Under the plan, the contractor, sub-contractor, or architect-engineer selects an insurance company to provide coverage. The insurance premium, which is of course paid by the War Department as part of the cost of the contract, will be paid at the end rather than the beginning of the insured period. It will consist of all the claims actually paid out, plus a sum, computed by formula, to cover the costs of operation of the insurance company. In effect, the Army makes itself a self-insurer but hires the insurance companies to provide technical claim-adjustment service. The contractor may also retain an "insurance advisor" (the agent or broker under another name) who will be paid a fee set by a formula.

The new plan covers workmens' compensation or employers' liability, automobile liability and property damage, and comprehensive public liability. It is to be used by all fee contractors whose insurance arrangements have not already been worked out and whose premiums, computed by standard rate books, would run to $5,000 or more. Previous practice was to buy insurance by competitive bidding, but it proved difficult to find an equitable basis for comparison of bids submitted by stock and mutual companies. Contractors still have the option, if they wish, of self-insuring in a manner satisfactory to the War Department.



Torrential rains fill Bartlett reservoir for first time

Filled for the first time since completion in May, 1939, Bartlett Dam, the U. S. Bureau of Reclamation's $5,200,000 multiple arch structure on the Verde River in central Arizona, successfully reduced the recent flood peak so that only minor damage was sustained at Phoenix. The 270-ft. concrete multiple arch dam, highest of its type known, will impound 200,000 acre-ft.

Roosevelt Dam, main storage reservoir of the Salt River Valley projects, sent water over the spillways for the first time in twenty years. Due to the heavy torrential rains on top of an excessive amount of rainfall during the past months, nearly 2,000,000 acre-ft. of stored water is available for irrigation in the Salt River Valley, as compared with less than 200,000 acre-ft. a year ago.

• • •

Labor troubles on army construction negligible

The War Department has announced that time losses and delays caused by labor difficulties upon the Army's temporary emergency construction program, now approaching completion, have been negligible, although ½ million persons were employed on these projects at the peak of operations.

A survey made by the Labor Relations Section of the Construction Division shows that as of April 5, 1941, only 14,875 man-days out of a total of 40,607,000 man-days had been lost as a result of work stoppages due to labor troubles, on the $1,200,000,000 building program. These figures are for 253 of the 271 projects authorized as of that date. The other 18 had not then been started.

This means, according to the survey, that the number of days lost during that period amounted to only three one-hundredths of one percent. The sole delays of consequence in retarding progress, it is reported by the Labor Relations Section, were occasioned by labor disturbances in outside industries engaged in the production of supplies.

The Labor Relations Section of the Construction Division is under the direction of James P. Mitchell, who advises on all labor problems that affect directly or indirectly the construction program in charge of the office of the Quartermaster General, of which Brehon B. Somervell, is chief of the construction division.

• • •

Army selects sites for pilot training schools

Sites for the first two flying schools in the U. S. Army Air Corps' 30,000-a-year pilot training program have been selected. A $3,100,000 project will be built at Dothan, Ala., and a $3,800,000 school will be erected at Harlingen, Tex.

Plans and specifications for housing, technical buildings, runways and other facilities for both schools are being prepared in the Office of the Chief of the Air Corps. The Corps of Engineers is charged with the construction.

Standardized cost estimating system adopted by Quartermaster Corps

Hope is that cost of new $2,500,000 army cantonment program can be estimated within 2 or 3 percent

A standardized method of estimating cantonment costs has been adopted by the construction division of the Quartermaster Corps, based on the unit design system used by E. H. Boeckh & Associates of Cincinnati. Boeckh, a reserve major, is head of the cost estimating section and has granted the use of his method and files to the War Department.

Construction Division Chief, General Somervell, described the system this week to a congressional investigating committee as evidence of the scientific methods being used in quartermaster construction programming.

A careful cost estimate is made for each of the 200 or so types of buildings used in the cantonment work. This estimate is made in terms of a standard set of cost values based on national averages a couple of years ago. The result is a "normal" dollar figure for a cost index value of 100. Next, the various buildings are grouped according to the weightings of the factors entering into their costs. At present twelve groups are used, identified as group A to group L, within each of which all the building types will have about the same percentage change in cost if the cost of a particular material or the wage of a particular craft changes.

Whenever the Army considers doing some building at a given location, an investigator there is required to fill out a detailed questionnaire, prepared by the cost estimating section, as to the prices and wages prevailing at that location. From this questionnaire, the cost estimating section computes twelve indices, one for each of the building-type groups. New questionnaires are received monthly from each location.

Monthly cost analysis

Thus there is obtained a monthly cost sheet giving the twelve indices for every location at which quartermaster construction is under way or contemplated.

If it is desired, then, to determine the cost of erecting a particular type of building at a particular camp, it is only necessary to note the "normal" cost of that type and the group into which it falls. The appropriate index number is then obtained from the latest cost sheet, and the normal cost is multiplied by the index to obtain its current cost at the desired location. It is believed that this method will give results correct to two or three percent.

The new system is not being used in connection with the present cantonment program. Its first use is in preparing budget estimates for Congress on the coming program. Later it will be used as a check on lump sum bids and as a basis of negotiating fixed-fee contracts.

Plans are now being worked out to apply the same system to utilities at cantonments.

When the next cantonment construction program gets going, observers close to the War Department believe, it will continue without substantial interruption through the rest of this year and into next. Army opinion now seems to be swinging to the view that, rather than stabilizing the size of the army at 2,000,000 or 2,800,000 men, the army should be increased all the way to its 4,000,000-man war strength as fast as troop housing and the modicum of equipment needed for training can be provided.

If this plan should be followed through, and there should be no A.E.F. like that of the last war to take the pressure off the cantonments, housing would have to be provided for some 2,500,000 more men—a two or two and a half billion dollar job.

First contracts in the new program will be let on a lump sum competitive basis, and this system will be held to as long as possible. But if cost fluctuations should result in hesitation by bidders or if the strategists get so far ahead of the engineers in their ideas on manpower that contracts have to be let without detailed designs, it will be necessary to go back to fee contracts.

Sites being selected

It is reported unofficially that nine cantonment sites have already been selected—near Blackstone, Va.; Augusta, Ga.; Neosho, Mo.; Fort Smith, Ark.; Columbus, Ind.; Santa Maria-Lompoc, Calif.; Medford and Eugene, Ore.; and Cookson Hills, Okla. Other possible sites are being actively surveyed.

Photo by Newark Evening News

Attention Saboteurs—this means you

When officials of Jersey City, N. J., decided that it was to the best interests of the municipality to stop airplanes from flying over its water reservoir at Parsippany, N. J., a novel idea in warning signs was originated.

At a number of strategic points on the banks of the reservoir were placed signs reading "Planes Stay Away." The letters in the sign are made of wood with each letter 10 ft. high, and each sign 140 to 150 ft. long. The letters are a deep red and contrasted against the green grass can be seen distinctly from a great height in the air. Two of the signs were placed on an inclined slope at the top of a retaining embankment of the reservoir directly adjacent to a state highway. By so placing these signs along the highway attention has been centered on the precautions being taken by the authorities to protect the water supply. Besides the warning signs, a high fence has been placed around the reservoir, and a force of guards is on duty as a further protection.

The warning signs and restrictive measures adopted by Jersey City officials were approved by the New Jersey State Aviation Commission. In the July 18 issue of ENR an article on "Sabotage and Water Service" was published, which covered a number of valuable suggestions and recommendations, among them the restriction of airplane operation in the vicinity of reservoirs and dams. (See ENR, July 18, 1940, p. 86.)

Most Beautiful Steel Bridges

(From top to bottom)

Susquehanna River—Class A

Between Havre de Grace and Perryville, Md.; J. E. Greiner Co., engineers; Bethlehem Steel Co., fabricators; Maryland State Roads Commission, owners. Contains 53 spans; total length 7,618 ft. abutment to abutment.

Dunning Creek—Class B

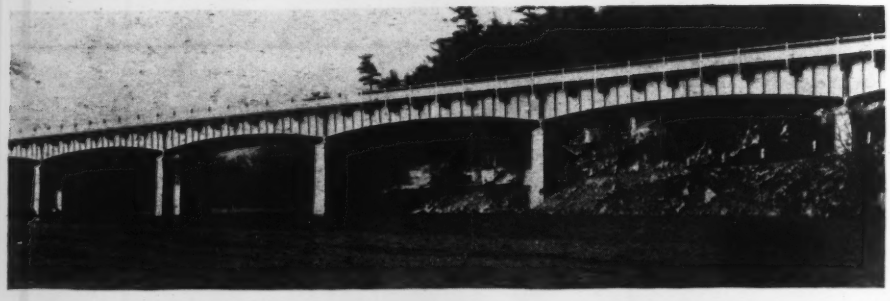
Pennsylvania Turnpike; Parsons, Klapp, Brinckerhoff & Douglas, engineers; American Bridge Co., fabricators; Pennsylvania Turnpike Commission, owners. Span lengths: 4 spans at 96 ft. and 2 spans at 48 ft.—total of 480 ft. between abutments.

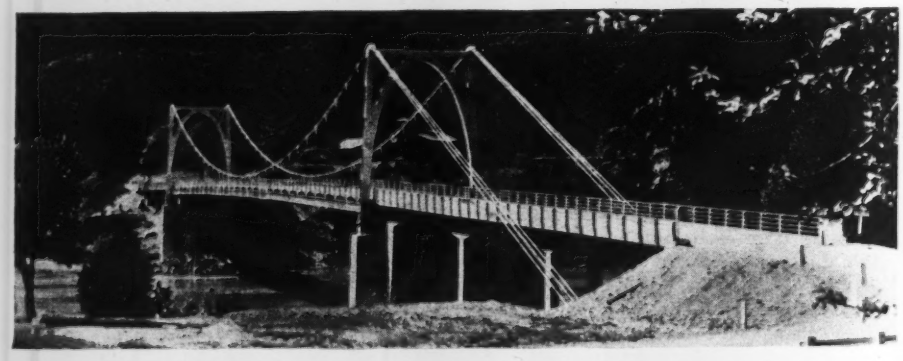
Klamath River—Class C

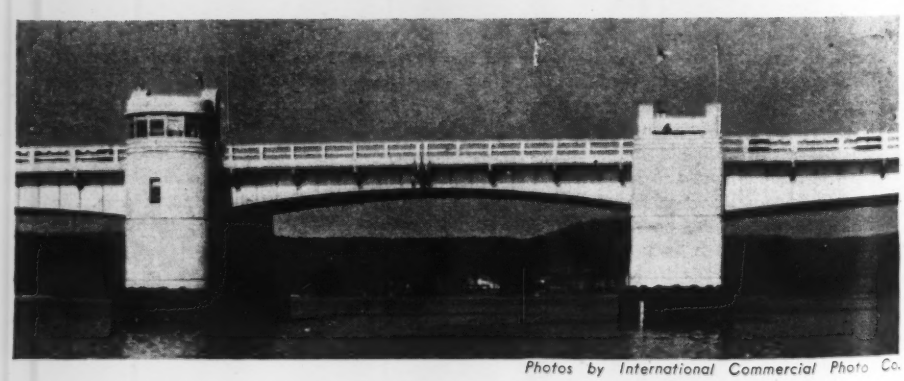
Humbolt County, Calif., C. H. Purcell, California state highway engineer; F. W. Panhorst, bridge engineer, Dept. of Public Works, State of California. Judson-Pacific Co., fabricators; State of California, owners. Span lengths: Main suspension span, 360 ft.; total length of bridge 665 ft.

Oceanic—Class D

Navesink River (north branch of Shrewsbury River) between Locust Point and Rumson, N. J.; Howard, Needles, Tammen & Bergendoff, and Morris Goodkind, engineers; Bethlehem Steel Co., fabricators and erectors; Monmouth County, N. J., owners. Bascule span length: 98 ft. center to center of bearings.







Photos by International Commercial Photo Co.

Prize awards made in steel bridge competition

The American Institute of Steel Construction, New York, N. Y., this week announced the prize winners in it's 13th annual competition for the most beautiful steel bridges erected during 1940.

For the purpose of classification all bridges costing $1,000,000 or more were grouped in Class A; those costing less than a million, but more than $250,000 were put in Class B; bridges costing less than $250,000 were placed in Class C, while all movable bridges were in Class D.

The awarding jury consisted of: Professor Francis P. Witmer, Dept. of Civil Engineering, University of Pennsylvania; Professor Edward J. Squire, Dept. of Civil Engineering, Polytechnic Institute of Brooklyn; John A. Thompson, Architect; W. Stanwood Phillips, Architect, and Waldo G. Bowman, Editor of Engineering News-Record.

Bridges receiving honorable mention are listed below, and the four prize winners are shown on the opposite page.

Honorable Mentions

OHIO RIVER BRIDGE (CLASS A)—Owensboro, Ky., Modjeski and Masters, engineers; Hunter Steel Co., fabricators; Owensboro Bridge Commission, owners; span lengths, 4,320 ft. of steel construction, of which the main bridge contains 4 multiple cantilever spans, of 342 ft. 9 in., 629 ft., 750 ft. 9 in., and 278 ft.

PENNSYLVANIA AVENUE BRIDGE (CLASS A)—Anascostia River, District of Columbia, Parsons, Klapp, Brinckerhoff & Douglas, engineers; McKim, Mead & White, architects; Bethlehem Steel Co., fabricators; District of Columbia, owners. Span lengths: 9 deck truss spans of 154 ft. each.

LAKEFRONT ROAD VIADUCT (CLASS B)—Cleveland, Ohio; John O. McWilliams, Cuyahoga County engineer; Bethlehem Steel Co., fabricators and erectors; Board of County Commissioners of Cuyahoga County, owners. Span lengths: 4 girder spans 858 ft., of which the longest is 270.8 ft.

FORT LITTLETON INTERCHANGE BRIDGE (CLASS C)—Pennsylvania Turnpike at Fort Littleton Interchange, Pa.; designed by Pennsylvania Turnpike Commission engineers; Bethlehem Steel Co., fabricators; Pennsylvania Turnpike Commission, owners. Span length of plate girder 108 ft. 4 in. center to center of bearings.

FLATBUSH AVENUE BRIDGE (CLASS C)—Belt Parkway, Brooklyn, N. Y.; Madigan-Hyland, engineers; Harris Structural Steel Co., fabricators; Dept. of Parks, City of New York, owners. Span lengths: 70 ft. each.

CAMBRIDGE CREEK BRIDGE (CLASS D)—Cambridge Creek, Cambridge, Md.; Henry G. Perring Co., engineers; American Bridge Co., fabricators and erectors (bascule leafs only); Maryland State Roads Commission, owners. Span lengths: one double leaf rolling bascule highway bridge 72 ft. long.

ERIE AVENUE BASCULE BRIDGE (CLASS D)—Black Run, Lorain, Ohio: J. W. Watson and Associates, engineers; Mount Vernon Bridge Co., fabricators and erectors; Lorain County Commissioners, owners. Span length: 333 ft.

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New York City engineers win promotions

Mayor LaGuardia of New York last week announced the promotion of chief engineer, Patrick Quilty, of the Department of Water Supply, Gas and Electricity to become head of the department to replace the late Joseph Goodman.

At the same time the mayor announced six other promotions involving civil service men who moved a notch nearer the top through Mr. Quilty's elevation. William H. Correale, who has been deputy commissioner in charge of Queens, will become first deputy commissioner of the department; William Flannery, deputy chief engineer, will succeed Mr. Quilty as chief engineer. The vacancy left by Mr. Correale's promotion will be filled by Richard Ankener, now an assistant engineer, supervising construction and distribution in Queens. In addition to these four promotions, the Mayor announced three others. Tobias Hochlerner, now an assistant engineer, will be promoted to deputy chief engineer; Harry Hollander, assistant to Mr. Hochlerner, becomes assistant engineer filling the position formerly held by Hochlerner, and Mr. Hollander's post will be filled by Charles D. Livant, an assistant engineer.

• • •

Defense needs may affect highway traffic striping

Chemical requirements for national defense may have an important effect on future traffic stripping programs.

In view of this fact, the materials laboratory of the Missouri State Highway Department is experimenting with traffic paint made with domestic ingredients.

Wide World Photo

New jobs for both of them

PATRICK QUILTY (left), last week, accepting his new job as head of New York City's Department of Water Supply, Gas and Electricity, This week, President Roosevelt appointed MAYOR LA GUARDIA (right) to head-up the government's new Civilian Defense.

Indiana extends help to another defense area

Indiana State Defense Council, which was recently created by the Indiana legislature to consist of the advisory council and an administrative council, is now to extend help to the small town of Kingstown by creating a field engineer's office at that point. The office will aid city, town and federal officials in solving the many sanitary, housing and other municipal problems arising due to a large influx of workers to build an army shell-loading plant at that point. The office will be similar to that at Charlestown, where the Army is now completing an $86,000,000 powder plant. At Charlestown James E. Zachary, field engineer, is employed full time.

In addition, at a later date, a third field engineer will be employed by dividing the state into three areas with a field engineer in charge of defense planning for each.

The advisory and administrative councils are appointed for two years.

The administrative council consists of: Clarence A. Jackson, executive vice-president of the Indiana Chamber of Commerce, chairman; John W. Ferree, director of the Indiana State Board of Health; Thomas R. Hutson, Indiana commissioner of labor; C. T. Malan, Indiana superintendent of public instruction; and Don F. Stiver, director of the Indiana department of public safety. This body has employed Henry B. Steeg as state co-ordinator.

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Sewage works association second annual meeting

Operation of sewage treatment devices will be the keynote of the second annual convention of the Federation of Sewage Works Associations to be held in New York City, Oct. 9-11. An entire session will be devoted to a symposium on operating problems, and this feature will be augmented by papers of more general appeal to the sewage works profession. The operation theme will be further advanced at a "sunrise breakfast" and round table discussion on topics of interest to sewage works operators.

The convention program and advance planning are in the hands of the following committee: W. J. Orchard, general manager, Wallace & Tiernan Co., Inc.; L. L. Luther, manager, Department of Sanitation, Freeport, L. I.; Clinton Inglee, president, National Water Main Cleaning Co., New York City; J. Herman Smith, sales engineer, Hersey Mfg. Co., South Boston, Mass.; C. A. Emerson, consulting engineer, New York City, and A. S. Bedell, chairman, New York State Department of Health, Albany.

JOBS OF THE WEEK

TRESTLE, Louisiana.

Brown & Root, Houston, Tex., will construct 18,750 ft. reinforced concrete floor trestle on timber foundation piles over Morganza Flood Way, between East Krotz Springs and Lottie, Pointee Coupee Parish. New Orleans, Texas & Mexico Railway, Houston, took bids and awarded contract at $2,198,388. C. S. Kirkpatrick, Houston, is chief engineer.

DREDGING, Oahu T. H.

Standard Dredging Co., Los Angeles, Calif., will dredge 14,270,000 cu. yd. in Keehi Lagoon, Oahu, for U. S. Engineers, San Francisco, Calif. $2,904,986.

LABORATORY BUILDING, North Beach, Md.

Charles H. Tompkins Co., Washington, D. C., has been awarded contract for the construction of a laboratory building, resident officers' quarters, dormitory and guard house for Bureau of Yards & Docks, Navy Department, Washington, D. C. Estimated cost is $1,000,000.

BLUE MOUNTAIN DAM, Waveland, Ark.

Myers, Myers & Goen, Salem, Ind., has been awarded a contract for the construction of 2,800 ft. long earthen Dam on Pettit Jean River, near here by U. S. Engineers, Little Rock, Ark. Cost is $1,111,879.

POWER PLANT, Norfolk, Va.

Burns & Roe, Inc., New York, N. Y., has been awarded contract for the construction of power plant improvements, and installing equipment consisting of generators, heaters, pumps, superheaters, alternators, conductors, steam piping, transformers, etc., for Bureau of Yards & Docks, Navy Department, Washington, D. C. Contract let at $1,225,000 on cost-plus-fixed-fee basis. Cleared through office of Production Management.

SCHOOL, New York, N. Y.

Depot Construction Co., New York, N. Y., will construct 4 story, Public School 120, for Board of Education, City of New York, Brooklyn, at $1,059,400. Eric Kebbon, at Division Design and Construction, Brooklyn, is architect.

LOCK, Hastings, Minn.

Winston Brothers Co., Minneapolis, Minn., is lowest bidder for constructing Landward Lock, masonry, Lock and Dam 2, Mississippi River here for U. S. Engineers, St. Paul, $1,536,168.

AIR GUNNERY BASE, Victoria, Tex.

American Construction Co., Houston and Victoria, Tex., has been awarded contract for expanding air gunnery base for U. S. Engineers, Galveston. Work will cost $1,344,560.

RAILROAD, Alaska

Seaboard Construction Corp., Mount Kisco, N. Y., was lowest bidder for constructing 11.2 mi. roadbed and 2 tunnels for Alaska Railroad between Seaward and Anchorage at $4,074,616. U. S. Engineers, Seattle, Washington, took bids May 12.

HOUSING, Roxbury (sta. Boston) Mass.

M. S. Kelliher Co., Boston, Mass., was lowest bidder when bids were opened May 14 for constructing 771 unit Orchard Park Housing Project by the Boston Housing Authority, Boston, for USHA. Estimated cost $2,896,000. J. A. McPherson, Boston, and John M. Gray, Boston, are associated architects.

FLOOD CONTROL PROJECT, Johnstown, Pa.

S. J. Groves & Sons Co., Boise, Idaho, was the lowest bidder for Flood Control Project Unit Number 5, Conemaugh River, Cambria County, when bids were opened May 16. $1,206,245 was lowest bid. Work includes widening, deepening and realigning channel of Stonycreek River, pavement and wall protection of banks of improved channel, altering existing pipe outlets, relocation sewer siphon and cast iron pipe mains. U. S. Engineers, Pittsburgh, will award contract.

NOTE—Additional bidding and contract news on over 800 projects large and small appear in the Construction News section beginning on page 137.

OBITUARY

CHARLES J. CAMPBELL, 45, Mississippi highway department engineer for 16 years, died at Forest, Miss., recently.

GEORGE EDWARD TAMM, 66, construction engineer who built the locks at Sault Sainte Marie, Mich., and many of the nation's docks and bridges, died May 17 at LaGrange, Ill.

GEORGE RAYMOND BURROUGHS, 86, retired city engineer, died May 12 at Oklahoma City, Okla.

HARRY W. PLUMMER, 75, former city manager of Asheville, N. C., died at Asheville May 8.

WILLIAM FULTON, 84, retired engineer of the East Bay (Calif.) municipal utility district, died May 11 at Berkeley, Calif.

HAROLD L. GIBBONS, 45, an assistant civil engineer with the New York State Department of Public Works, was accidentally killed at Albany, N. Y., recently.

REUBEN STOWELL, 64, retired construction engineer for the Chicago, Milwaukee & St. Paul R. R., died May 12 at Ramsey, N. J.

MATTHEW R. HURST, 67, well known building contractor at Buffalo, N. Y., died May 10.

ALFRED ANDERSON, 82, retired Chicago building contractor, died May 11 at Los Angeles, Calif.

ALBERT STEARNS KENDALL, 58, building contractor, died May 13 at Boston.

DANIEL B. PENROD, 81, prominent building contractor of Lincoln, Neb., died May 5.

JACOB S. SMITH, 80, retired contractor and builder, died at Birmingham, Ala., on May 7.

CONRAD GRIMMER, a prominent retired contractor of Cape Charles, Va., died May 9.

• • •

Chicago windstorm causes $250,000 damage

A 60-mile windstorm, last week, hit Chicago causing some $250,000 in damages to various structures.

At Rubinkam Airport, 167th St. and Western Ave., three new airplane hangars, one of them more than 100 ft. long, and 29 planes were destroyed as wind ripped off the hangar ends, pushed out the walls and dropped the heavy roof trusses on the craft sheltered inside. At Lewis Field, near Lockport, 35 miles west of Chicago, the roof of a metal-sheathed hangar of the Lewis School of Aeronautics was lifted off the walls, and the walls twisted askew and partly caved in to cause damage to seven planes housed therein.

Possibly most spectacular was the wrecking of a 12-story construction elevator on the U. S. Customs House at Harrison and Canal Sts. Fused by a lightning bolt, the steel tubing of the elevator bent at the building's 8th floor. The wind blew the upper half of the structure outward so that it hung over the street. The elevator had been used to add four stories to the 8-story Custom House.

TVA employment at an all-time high peak

With the Tennessee Valley Authority augmenting its man-power to speed the work of national defense, an all-time high employment peak with 19,444 employees was reached on April 30, so states director of personnel, A. S. Jandry.

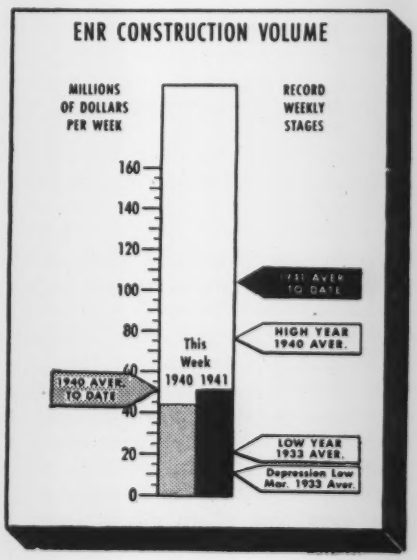
The new high for the Authority's eight years of operation is larger by almost 900 than the previous peak of last December, when 18,588 were employed, and 3,000 larger than the highest pre-emergency employment, recorded in August 1935. TVA work will rise still further this summer.

CONTRACTS AND CAPITAL

ENGINEERING CONSTRUCTION awards for the week, $52,346,000, are 19 percent higher than in the corresponding 1940 week, but 45 percent below the total for last week. The week's volume, although at the lowest level in 1941, is the 38th consecutive week to register a gain over the respective weekly values of a year ago.

Private awards are 10 percent above the 1940 week, but are 53 percent under last week. Public construction is 24 percent over a year ago, but 40 percent below a week ago.

Construction volume for the year to date, $2,181,814,000, is 106 percent higher than in the 21-week period last year. Federal construction for the 1941 period, $1,048,345,000, just about equals the $1,058,278,000 reported for all construction in the 21 weeks of 1940. Private awards are up 63 percent compared with a year ago. Public construction is 130 percent higher due to the 751 percent gain in federal work.



In the classified construction groups, gains over the 1940 week are in bridges, public buildings, earthwork and drainage, and unclassified construction. Increases over last week are in waterworks, sewerage, bridges, earthwork and drainage, and streets and roads.

New capital for construction purposes for the week totals $6,186,000. It is made up of $6,046,000 in state and municipal bonds, and $140,000 in corporate security issues.

New construction financing for the year to date, $3,237,025,000, is 463 percent above the volume for the 21-week period last year.

CONTRACTS

(Thousands of dollars)

	Week Ending May 23 1940	May 15 1941	May 22 1941
Federal	$5,179	$35,766	$13,331
State & Municipal	23,587	23,838	22,452
Total public	$28,766	$59,604	$35,783
Total private	15,091	35,387	16,563
TOTALS	$43,857	$94,991	$52,346
Cumulative 1941 (21 weeks)			$2,181,814
1940 (21 weeks)			$1,058,278

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1940 21 weeks	1941 21 weeks
NON-FEDERAL	$575,644	$368,188
Corp. Securities	74,644	109,342
State & Mun.	416,884	209,067
U.S.H.A. loans	78,430	22,550
R.F.C. loans	5,686	27,229
FEDERAL		$2,868,837
TOTAL CAPITAL	$575,644	$3,237,025

FHA MORTGAGES

	Week Ending May 18 1940	May 10 1941	May 17 1941
Selected for appraisal	$29,703	$34,156	$35,266*
Cumulative 1941 (20 weeks)			$556,089*
1940 (20 weeks)			$474,282

* Subject to revision.

ENR INDEX NUMBERS

Index Base=100		1913	1926
Construction Cost	May '41	255.55	122.84
Building Cost	May '41	209.24	113.11
Volume	Apr. '41	322	141

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Current Economics

Sir: In seeking the cause of unemployment, Geo. O. Consoer, in his "Future of Work Relief" (ENR, March 13, 1941, p. 388), should have considered other current economic phenomena. Professional economists generally agree that the U. S. became a creditor nation during the first World War. What can be expected to happen when a creditor nation maintains a protective tariff? A creditor nation can be defined as a nation whose citizens have more invested abroad than the citizens of other nations have invested in it. This surplus of investments should draw a surplus of interest and dividends. This surplus, however, cannot be paid in goods because the tariff prevents it, so it has to be paid in international money, which is gold. That is why we have 75 percent of the world's gold. The value of gold ultimately increases because foreign nations cannot get enough of it to pay their debts to the U. S. Is it not this increase in the value of gold that is causing "A pronounced slackening . . . in private heavy construction where a large part of the unskilled labor ordinarily is employed?"

What benefit is a protective tariff to a creditor nation? For 50 years after Great Britain started her free trade policy, she had greater prosperity than she ever had before. A creditor nation is supposed to be better off than a debtor nation, but how can we prove it unless we accept goods in payment of interest and dividends?

JOHN M. WOODS,
Buffalo, N. Y.

Steel in the Warehouses

Sir: In the March 27 issue, p. 458, you published a letter from Mr. Iden of the American Institute of Steel Construction, saying that "there is no shortage of structural steel shapes for defense work or civilian needs." I believe that any fabricator of structural steel or manufacturer of construction equipment will violently argue this point. When it takes anywhere from four to twelve weeks to get steel shapes, a manufacturer assumes there is a shortage somewhere.

However, I suspect Mr. Iden may be quite correct: the shortage may be artificial. Just recently a steel warehouse in a small eastern city called up a contractor friend of mine and wanted to rent his equipment yard. They said they had 25 carloads of warehouse steel coming in, and that their warehouse was full. This may explain the apparent shortage: the warehousers have immense standing orders with all the mills, and when the mills aren't rolling on A-1 priorities, they are rolling for the warehousers. Orders from manufacturers are dragged along until they cancel them in disgust and buy steel from the warehouse.

This is a serious and unnecessary situation. Defense orders are being delayed by slow delivery, while shops are not working to their ultimate efficiency because of piece-meal delivery.

ROBERT S. MAYO
Lancaster, Pa.

The Inspection Problem

Sir: After reading your editorial and Mr. DuPuy's article on inspection in the issue of April 10, I thought of some of my experiences, both as an inspector, and as foreman and engineer in the employ of contractors. And having seen the problem from both angles, I am submitting a list of my ideas on the subject in the hope that they may be worth a review by the readers of *Engineering News-Record.*

1. Of prime importance are clearly written, practicable specifications. Before a contract is let, the specifications should be carefully reviewed by a field engineer with a background of adequate construction experience on the types of work embraced in the proposed contract. Specifications are too often written by men with little practical knowledge of the exigencies of construction. Many words could be eliminated to the benefit of both contractor and owner.

2. If possible, the same field engineer mentioned above should interpret the specifications and select the men who will have to enforce them.

3. Inspectors who are to act in a supervisory capacity should have had field experience in the type of work to be done. The best inspectors are former engineers and foremen who have supervised the intimate details of similar work.

4. Pay better salaries and use less men. Some operations require only occasional inspection; continual mediocre inspection may be less effective than an examination of the work at intervals by a competent inspector.

5. The inspector should have full authority. If he is not worthy of that, he becomes little more than a spy for his superiors.

6. Before a new phase of the work is started, it should be discussed by the chief and his assistants with the contractor's representatives, and as far as possible any questions regarding specifications and methods should be decided and agreed upon in advance.

7. Cut out unnecessary paper work. Good records are necessary and should be kept, but inspectors often waste much time collecting and preparing data which are of small value.

8. Last but not least: eliminate politics from bottom to top of the organization. With that done, the other rules are simple; without it, they mean nothing.

A. E. CORNELL
Assistant Resident Engineer
Pennsylvania Turnpike Commission
Harrisburg, Pa.

Bridge Vibration Periods

Sir: I note comment in your issue of Feb. 27 in regard to different types of stays to improve the aerodynamic stability of suspension bridges. It is my opinion that certain simple changes in design would eliminate the necessity for other than minor cross-stays.

Now, I am a mechanical rather than a structural engineer. I have in the past made some extended designs in high-speed rotors for turbines and compressors. Critical speeds in high-speed machines do the same trick to the machines as the vibration did to the Tacoma bridge. However, modern designers get around this very nicely by testing for the critical speed in new designs and then altering the design so that the rotor will not have

to operate in the dangerous range. In some machines critical speed is of no serious consequence, while in others it is just too bad.

In the case of the Tacoma bridge, it is probable that if the police had rushed every available auto onto the bridge the vibration period would have been changed out of line with its maintaining force and the bridge might not have gone down.

A major error in the bridge, it would seem, was a too "one-piece" construction so that there was no place for the vibration to be absorbed. Also, all four vibration loops happened to be too closely tuned. These vibration loops would be the two halves of the main span and the two outer ends beyond the towers. It is the custom of suspension bridge builders to build two identical towers—if possible—and two identical end-sections with anchorages.

My suggestion is that all future suspension bridges be built with unequal towers and unequal loading. This can be readily done. One tower should be much shorter and stouter than the other. Both ends and anchorages should be substantially different. A tuning fork has both legs of equal length and size. A bridge should not, as we do not want it to vibrate.

FRANCIS D. CHAPIN
Saco, Maine

Taps on Tapped Pipe

Sir: Comments in the letter of Prof. Ralph W. Powell, (*ENR*, April 10, 1941, p. 36) regarding my solution (*ENR*, Jan. 16, 1941, p. 75) of the loss of head, in the particular example, with the quantity of flowing water, pipe size and spacing of nozzles, given in the article on *Loss of Head Determination in Uniformly Tapped Pipes* by R. D. Gladding, (*ENR*, Nov. 21, 1940, p. 67) call for further discussion.

In the case given by Mr. Gladding, the recovery of velocity head which occurs in the pipe at each branch outlet is very small compared to friction loss and was intentionally neglected as observed by Mr. Powell. The turbulence in the pipe at each outlet decreases any head recovery. (See Ernest W. Schoder and Arthur N. Vanderlip, *Long Versus Short Body Fittings*, Cornell University Engineering Experiment Station, *Bull.* No. 20, p. 13, which shows that instead of a recovery at a branch, a small amount of head is actually lost.)

The example given by Mr. Powell is entirely different from the one given by Mr. Gladding. Outlet nozzles are spaced nearer to each other and friction in the main pipe is smaller. Mr. Powell has allowed for recovery of velocity head but it does not appear that eddy losses in the pipe at the nozzle outlets have been taken into consideration. This is as important as the recovery of head. Moreover, Mr. Powell's example was worked out on the basis of Bernouilli's Theorem, but this theorem is applicable to cases where the same quantity of water is flowing throughout the length of the pipe or channel. This condition is not met because a fraction of the approaching water leaves the main at each outlet. Hence, the quantities of water in the main pipe, approaching a branch and leaving it, are unequal. Therefore, it would be interesting to know how Mr. Powell applies Bernouilli's Theorem in his example.

The remarks made by Prof. W. M. Lansford in his letter (*ENR*, April 10, 1941, p. 36) regarding the difficulties of the solution of the problem are correct. It could be said further that its analytical solution is impracticable. Therefore, the necessity of deriving a general formula is questionable, especially when all of the factors which influence the flow are not taken into consideration. My conclusion is that the one practical solution of this problem and others similar to it, is to proceed from point to point, as indicated in my letter of Jan. 16, 1941.

FREDERICK C. ZEIGLER
New York, N. Y.

Cavity Wall Used Before

Sir: In *ENR*, Feb. 13, 1941, p. 11, in an article titled "Developments in Building," there is the statement that brick cavity walls were used for the first time in this country in a Montclair, N. J., apartment house. I take exception to this statement.

I feel sure that this type of wall construction has been in use in this country for a number of years, for details of the method appear in Architectural Graphic Standards by Ramsey and Sleeper (John Wiley & Sons —edition of 1932). The architectural details collected in this book are largely taken from executed work.

Furthermore, the work of the architectural firm of Ford & Swank includes a house in Dallas, Tex., for Earl Hart Miller using a 12-in. wall with a 4-in. air space in the center. We used a hard-burned common brick with integral waterproofing in the mortar, and plastered the cavity side of the inside course of brick. We used quarter-inch bars bent in a Z-shape, placed 20 in. apart every fifth course to tie the two courses together. This house was completed in November, 1939.

In addition, there is a house by this firm here in San Antonio completed in 1938 using this type of wall. And in 1938, we completed a house on San Jose Island, Tex., for S. W. Richardson, using the same system with the exception that concrete block instead of brick was used.

We have found this type of wall very satisfactory from the standpoint of economy and good construction.

GERALD R. ROGERS
Ford & Swank, Architects
San Antonio, Tex.

What Tin Cans Are Worth

Sir: On p. 735 of *ENR*, May 8, 1941, at the end of an article entitled *Are Tin Cans Worth Salvaging?*, an editor's note refers to the salvaging of tin cans by the Washington Suburban Sanitary Commission at a profit of $7.00 per ton; reference is made to the article on p. 348 of *ENR*, Feb. 27, 1941.

We are salvaging tin cans and selling them in bales for $9.00 a long ton, and we are making a profit on this transaction, but we are not netting anywhere near $7.00 a ton. Our last check on costs in connection with salvaging operation shows a net profit of $3.67 for a long ton. Transportation costs amount to $2.24 and all other costs, including labor, electric power, fixed charges on the complete baling installation, and engineering and administrative, amount to $3.09 per long ton.

We hope to better the amount of profit because of the greater quantities of cans being received at the baler, but I do not believe we will ever reach as high a figure as $7.00 a ton unless the price received for the baled cans is increased.

HARRY R. HALL
Chief Engineer
Washington Suburban Sanitary Commission
Hyattsville, Md.

EDITORIALS

VOLUME 126 NUMBER 21

May 22, 1941

What About the St. Lawrence?

EVER SINCE representatives of this country and Canada signed an agreement looking toward an early start on developing the St. Lawrence River for navigation and power, the country has been besieged with claims and counterclaims whose net result is largely confusion. What is the St. Lawrence project? What will it cost? Is there sufficient traffic to warrant building the seaway? Is the power needed? Until the facts that bear on such questions are known this confusion will persist. This issue contains a special report on the St. Lawrence project whose purpose is to present these facts in as unbiased a form as is humanly possible. What work is now proposed and what it is expected to cost can be answered with little difficulty; the cost figures given, brought together for the first time since the agreement was signed, are all from official sources. Questions relating to economic considerations are less easy to answer categorically, so that both pro and con arguments are presented whenever possible. Finally, the report attempts to show what appear to be the trends in national and world affairs that already have had or soon will have a significant bearing on the proposed development. It is hoped that the report will aid our readers to form their own opinions as to the merit or lack thereof in the St. Lawrence power and navigation project.

No Skyscrapers over Miami Beach

BUILDINGS OVER 14 stories high have been prohibited in Miami Beach, Fla., under a recent ordinance whose passage newspaper accounts credit to a desire for safety against hurricanes. What reasons each city council member had for favoring the ordinance are not known, but it is doubtful if the hurricane safety argument figured prominently. It is, of course, completely fallacious, for tall buildings can be made just as safe against wind as shorter ones. Even in the 1926 hurricane, when tall buildings design was much more empirical than it is today, only two of the twenty skyscrapers in nearby Miami were damaged severely; and neither of these damaged buildings, which were subjected to three times the wind load for which they were designed, came near to collapse. Buildings taller than 14 stories might be undesirable in Miami Beach for a number of reasons—esthetically, for their effect on existing real estate values, or for lack of satisfactory foundations—but danger from hurricane is not one of them. With the existing knowledge of steel and reinforced-concrete frame design and of the means of securing efficient interaction of frame, walls and floors, which the Florida hurricane itself taught, tall buildings can be as safe in Miami Beach as in New York.

Butt-Welded Reinforcing Bars

EFFICIENT USE of reinforcing steel results when the bars function as continuous elements over any distance required by the designer. The earliest method of accomplishing this result was to utilize the natural bond of the concrete in a relatively long overlap of the bars. An improvement was the introduction of lap welding, with corresponding reduction in steel and improved efficiency. Today the ultimate is approached by butt-welding the bars at splice points, an outstanding example being the continuity provided in the heavy layers of two-inch square bars in the record-breaking piers of the Pit River Bridge, reviewed elsewhere in this issue. The wider adaptation of this relatively new development to smaller structures and different types of design has the double merit of reducing the amount of steel and insuring a more efficient relation between material and design requirements.

Strikes on Defense Construction

LESS THAN ONE PERCENT of the forty million man-days required for the Army's emergency building program has been lost by work stoppages due to labor troubles. This is an impressive record, especially when considered in the light of the strike delays that have plagued the manufacturing industries. In many cases, of course, construction labor peace was bought by permitting unionization in areas previously unorganized and by allowing the union to exact tribute from the workmen in the form of excessive fees. In short, defense construction has gone ahead virtually without interruption, but at a price. Part of this price is measured by the increased cost of construction to the nation and part by the fact that many of these new and unskilled union members will henceforth insist upon being classed as skilled mechanics and paid accordingly. The construction industry and the consumers of its products will pay installments on the cost of

this labor peace for many years to come. In pointing with pride to the absence of strikes on defense construction jobs, this sobering fact should not be forgotten.

Non-Defense Public Works

CONSIDERABLE INTEREST is being manifest in Congress in the curtailment of federal expenditures for non-defense activities, including public works of a non-defense character. It is not too soon. Lip service, even from high places, has been given to the business-as-usual ideal, but no one who appreciates the defense and aid-Britain task that we have set ourselves actually believes that we can superimpose it on our normal activities. Most of these will have to be curtailed, and some will have to be postponed. The sooner we are resigned to this fact, the better.

In its job of cutting non-defense expenditures Congress will encounter a much more sympathetic and cooperative spirit in the construction industry than in some other quarters, agriculture and the political social betterment agencies, for example. For that reason it may be tempted to pull its punches on these pressure groups and try to make public works the principal victim. That would be a mistake if in the process projects vital to defense were crippled. And there is real danger that the defense effort may suffer if Congress attempts to push its luck too far in curtailing public works.

For example, to economize on federal aid to highways insofar as the strategic network or defense access roads are concerned would be the height of shortsightedness; there has been too much of that already. To postpone power projects that can be turning out needed kilowatts in a reasonable time would throttle the defense effort. Likewise, to postpone flood control projects whose purpose is to protect industrial cities would be taking an unnecessary gamble. There are road projects that are too ambitious, dams whose power production will be too remote, flood control projects that are not necessary to defense, reclamation projects that could be postponed, and these are rightly among the candidates for the axe of economy. But careful analysis and discernment are required to separate them from those public works whose stoppage would be harmful.

In its efforts to keep the national tax bill to a minimum consistent with our defense aims, Congress will have the undivided support of the construction industry, which is doing a magnificent job in helping the country to achieve these aims. But this support should not be taken as acquiescence in any plan to place the whole burden of economy on public works and let the non-defense activities that are backed by political pressure groups go on as usual. Any such plan will be bound to damage the defense effort, and that would be economy in reverse.

New Plan for Housing

WORKING WITHOUT FANFARE, a special division of the Federal Works Agency is conducting a notable experiment in housing. Now nearing completion near Camden, N. J., is a 500-family "village," the financing, administration and construction of which has significant implications for future developments in low-cost housing.

Audubon Village, as the project is known and described in this issue (p. 53), is a government-financed community for defense workers. But Uncle Sam acts only as a real-estate promoter. Upon completion, the project will be turned over to a mutual housing corporation, the stockholders of which will be the people who buy houses with monthly payments. Based on proven mutual insurance principles, this plan puts home ownership on an attractive rental basis.

Administration of housing under the "Camden Plan" has two principal aspects of attractiveness. First, it is designed to give an industrial worker the advantages of home ownership without the disadvantage of anchoring him to a fixed location; should he have to move elsewhere he can relinquish his home-ownership obligations with no financial loss. Second, the mutual insurance plan of financing offers an opportunity for private capital to enter the industrial housing field with certain guarantees for a return on the investment.

Construction of houses using prefabrication methods is the final element of special interest in Audubon Village. As a large scale demonstration of what can be done when construction is carried out in the factory and only assembly is assigned to the field, the project merits careful study. In all respects, therefore, we may look upon this venture as a fresh approach to low-cost housing.

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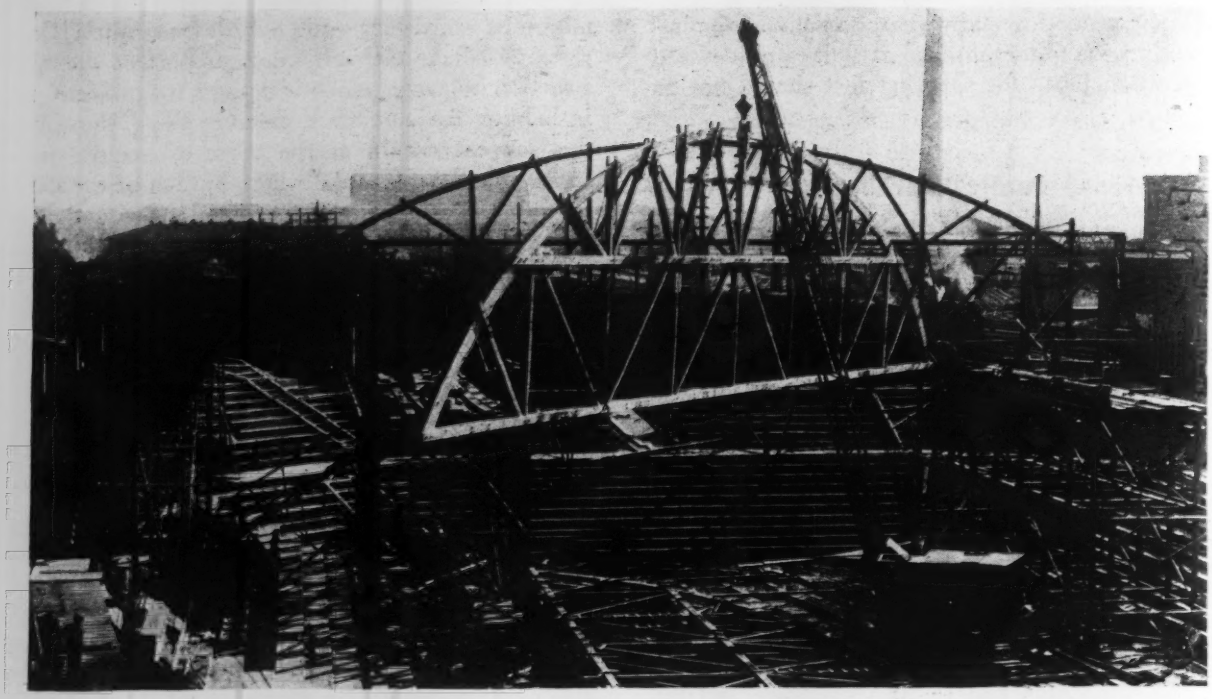


For pouring 72-ft. lengths of barrel shell concrete arch these five timber trusses were used to support the form for the 132-ft. span. The form moved on wheels along rails on the trestles, which were required to clear bleachers along sides and ends.

Barrel Shell Roof for an Ice Arena

R. L. Bertin
Chief Engineer, White Construction Co., Inc.
New York

***Contents in Brief**—Construction sequence, which required building of bleachers first, required use of trestles to carry timber arch trusses for ice arena in Washington, D. C. Trusses fabricated on ground and raised to position. Moved on wheels and supported by jacks during pour. Concrete test beams used to determine 2,000,000-lb. modulus which was the requirement for striking the arch form.*

A MOVABLE TRUSS ASSEMBLY traveling on timber trestles, to carry the form used in concreting a 132-ft.-span barrel-shell roof, was the notable construction feature in building the Uline Arena in Washington, D. C. The required sequence of construction, which called for the building of the bleachers first, made the 25-ft. height of trestle necessary to permit the arch form to be moved along the entire 324-ft. roof length of the structure. Design of the form and the trestle involved problems of providing adequate support during moving and pouring operations, cantilever end sections with necessary provisions for temporary support, and rigidity of the form cross-section under load. The solution of these construction problems is reviewed in the following paragraphs.

The building serves the primary purpose of providing an ice rink 88 x 218 ft.—largest ice area of its type east of St. Louis—with spectator seating capacity of 5,064. When the rink floor area is used for seating, an auditorium is provided which has a seating capacity of 7,000. Located immediately adjacent to the owner's existing ice plant, the required refrigeration for the rink is available without the need of equipment space or installation within the building.

The skating rink proper was built to conform with the plans and specifications prepared by M. R. Carpenter for a floating floor of the center trench type. This floor consists of a sand bed 8 in. thick on top of which a 5¾-in. concrete floor was poured and finished to a dead level surface. Within the concrete are embedded the refrigerating pipes, reinforcing bars and such equipment as is required for operation. When the rink is drained, a movable wooden floor installed and 1,900 seats added, the building provides one of the largest auditoriums in Washington, representing one of the functions for which the structure was intended.

The building incorporates a roof of the Roberts and Schaefer design of thin concrete shell commonly

known as the "Z-D System." The principles of this design, which has been used in this country for a number of installations, have previously been reviewed in the pages of *Engineering News-Record* and will not be described in detail. An article appearing in the April 8, 1937, issue presented a detailed review of this type of roof system and its use for the ice arena in Hershey, Pa. A shorter article in the issue of April 14, 1932, outlined the European development of this design and indicated its introduction in this country.

Roof design

In general the roof design calls for four reinforced concrete arch ribs 18 in. wide and 5 ft. deep at the crown, increasing in depth to a horizontal dimension of 16 ft. 4 in. at wall level. These ribs are spaced 36 ft. on centers and support the thin reinforced concrete barrel roof which is 3⅝ in. thick at mid-span between ribs and increases to a maximum thickness of 5¼ in. at the supports. Four expansion joints divide the 324-ft. length of barrel into two 54-ft. end sections and three 72-ft.-wide sections. These expansion joints are located halfway between every second rib and at these locations the barrel shells are stiffened by an edge rib of 12 by 30 in. section. The open joint is made weathertight by means of a V-shaped, copper strip joined to the roofing material of the adjacent roof sections.

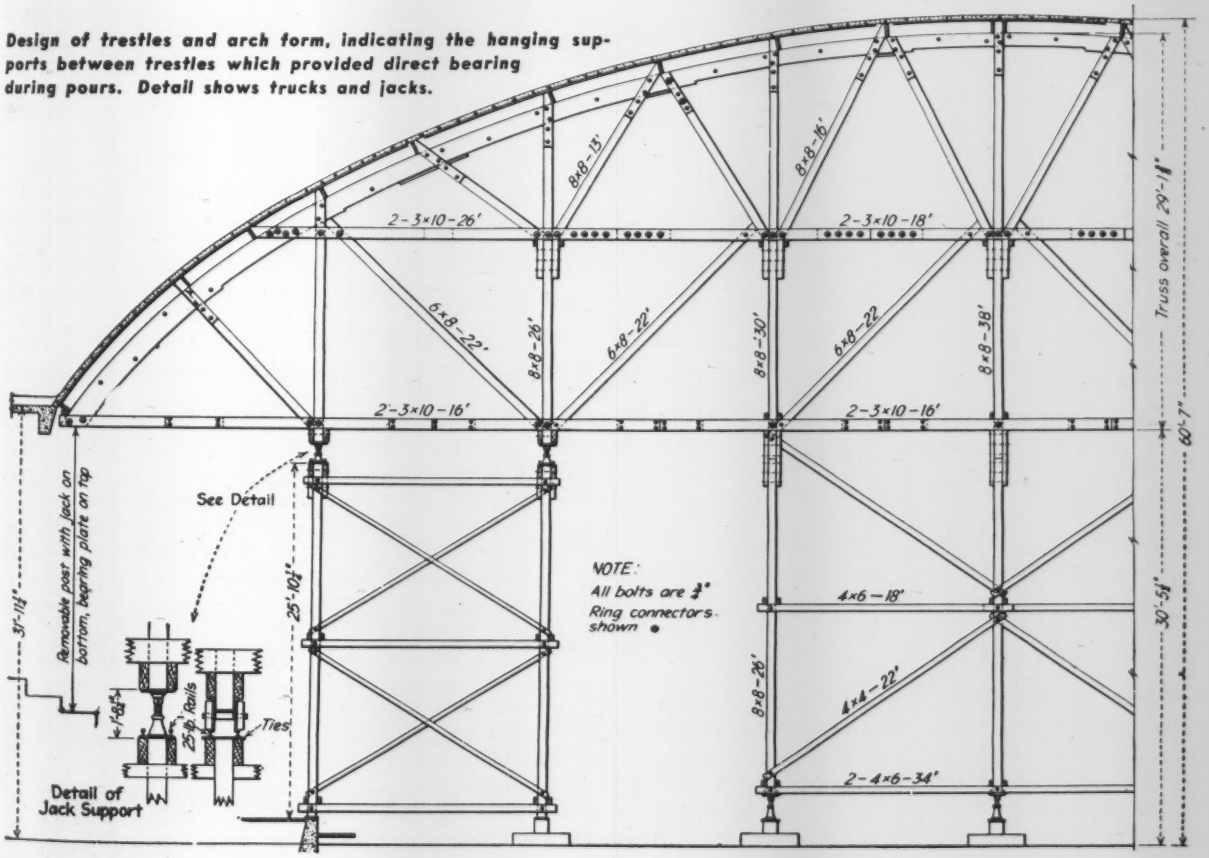
Outside ribs

The distinguishing feature of this roof design, as compared to the roof over the Hershey rink, is the fact that the ribs are placed on the outside of the barrel, providing a clear arched ceiling for the structure. This design improves the appearance of the building interior and simplifies the moving of the form system.

The cross-section of the building indicates that the framing of the concrete bleacher seats involved direct support on the end building walls in addition to intermediate columns. This required the completion of the bleacher seats prior to the construction of the barrel roof. In fact, the walls and the brackets to carry the roof ribs were completed before the arch forms were assembled and lifted to position on the supporting trestles.

The distinctive feature of the supporting system for the roof forms was the use of two longitudinal timber trestles, built progressively the length of the building, which permitted the centering to be moved at an elevation high enough to clear the bleachers at the ends and along the sides. These trestles consisted of two-post bents of conventional framing resting on timber cribbing. At the ends of the building, to avoid undue strains in the bleacher structure, temporary holes were left through the bleachers so that the trestle legs could extend through to direct bearing on the ground.

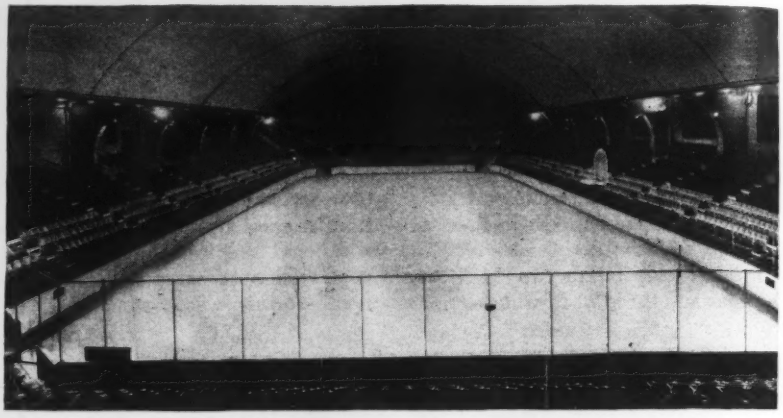
The trestle bents had a width of 15 ft. 8 in. and over each leg carried 25-lb. rails spaced 10 in. apart. These rails supported the four lines of double trucks which carried the arch form and the 10-in. spacing between rails allowed for jacks which were used to raise the forms and wheels off the tracks during concreting. The two trestles were spaced 78 ft. 4 in. on centers, or 62 ft. 8 in. in the clear.



Design of trestles and arch form, indicating the hanging supports between trestles which provided direct bearing during pours. Detail shows trucks and jacks.

***Pouring a 72-ft. section of arch,** including the two outside ribs, involved 230 cu. yd. of concrete and required about 9 hr. Both sides were carried up evenly and the dry mix made outside forms unnecessary.*

Around the 88 x 218-ft. ice surface the seating capacity is 5,064, and when the rink is drained and wood floor installed an additional 1,900 seats makes this one of the largest auditoriums in Washington, D. C.



The moving form which operated on these two trestles consisted of five timber trusses spanning between trestles and cantilevering a distance of slightly more than 18 ft. at either end to complete the clear span of 132 ft. between the previously poured edge beams. These trusses were designed to carry the full load of the formwork, but not the load imposed during concrete placing. For this purpose hanging supports (see drawing) were provided at each panel point between the trestles. This supporting system was suspended from the trusses during moving, but when the form was in the position for a pour, jacks were used to raise the entire framework from the tracks. These jacks on the trestles and under the suspended supports raised the form a distance of about 2½ in. to final grade and were used to lower it back on the tracks after the concrete had obtained sufficient strength. Thus, truss action was not involved in this supporting system for carrying the weight of concrete, but the trusses were expected to redistribute loads in case of any uneven yielding of the supports.

The five trusses making up the supporting system were spaced at 18-ft. centers expecting the two end panels, which were spaced at 15 ft. in order to clear the end wall construction. The decking on top of the trusses was made 76-ft. long to receive the 72-ft. section of roof between expansion joints.

The top chords of these trusses were fabricated in the shop of Roof Structures, Inc., and were made from 2x4-in. and 3x4-in. lumber bent and glued together to conform to the required curvature of the arch. They were proportioned to resist the worst combination of loadings at all points. These prefabricated chord units in 35-ft. lengths were assembled at the site (see illustration) using ring connectors to complete the chord and the entire truss system.

The five truss units were lifted one at a time into position on the trestles by a crawler crane. They were then braced together and 2x12-in. joists were used to span across the trusses and beyond forming the 76-ft. length of decking, which was completed by adding a ⅝-in. thickness of Douglas fir plywood against which concrete was poured.

Form operation

With the form in position, it was jacked up to proper grade at both the supporting points over the trestles and under the suspended section. The cantilever ends of the trusses were also supported by timber struts and jacks. Reinforcing steel for the 72-ft. length of shell was then placed in accordance with the special pattern called for by the roof system. Vertical form panels for the arch ribs were then placed enclosing their reinforcing steel.

Concrete was delivered by mixer truck to a hoisting tower which elevated it to a timber bridge spanning the arch at crown level. Concrete was buggied and deposited by chute. The pour was built up from the haunch of the arch form, being carried up evenly on both sides. Pours consisted of about 230 cu. yd. and were continuous for the entire 72-ft. section of shell, including the two ribs. Pouring time for this section of arch represented about nine hours for a crew of 40 men.

The consistency of the mix was set stiff enough to eliminate the need for outside forms on the lower part of the arch. Concrete was struck off with timber screeds operating from headers to provide the required shell thickness. This outside concrete surface was screeded to a surface sufficiently smooth to receive the 4-ply built-up roofing.

Concrete mix and curing

The concrete mix was of the follow-

ing proportions: 2,408 lb. of high-early-strength cement, 5,006 lb. of sand and 7,952 lb. of ¾-in. gravel. Because some of the concreting was carried out during the winter months, the mixers left the plant at temperatures varying from 70 to 100 deg. Air temperatures during placing were as low as 26 deg., and provisions were made for maintaining concrete temperatures above a 50 deg. minimum during curing.

The underside of the form and the top surface were closed in with tarpaulins and the space kept warm by means of salamanders. For each pour, test beams 4x6 in. by 4 ft. 6 in. were made and cured under conditions simulating the concrete in the roof. At the end of five days these specimens were tested as beams with a center load and deflections measured. With these data, the modulus of elasticity was computed and used as the determining factor for stripping. The required modulus of 2,000,000 lb. was met in every case and the arch form was struck five days after completion of the pour.

When the form was ready for stripping, the jacks were released and the trusses lowered onto the trestle rails. No difficulty was experienced in this step in the process. The form was then moved ahead by four hand winches pulling on a ⅜-in. steel cable fastened to the end of the trestle through a system of blocks. As the form was pulled ahead, concrete finishers working from staging attached to the end of the form finished the inside surface of the concrete. The rate of form advance was determined by the finishing operation. During normal procedure time required between stripping and setting up the form for the next pour was about four hours.

During pours the trusses were jacked up off the wheels and the form elevated to exact grade.

The structure is owned by M. J. Uline. J. H. Lapish of Washington, D. C. was the architect and the shell roof was designed by Roberts & Schaefer Co. of Chicago. E. C. Molke was the engineer in direct charge of design.

The general contract was executed by the White Construction Co., Inc., of New York. The writer is chief engineer and Harry E. Tear general superintendent.

Cement-Stabilized Highway Base Plant Mixed in California

EXPERIMENTS with different methods of laying cement-stabilized base for pavements resulted in the series of operations described in the March bulletin of the California Division of Highways by A. Everitt Smith, assistant highway engineer. On 6.12 miles of road between Beaumont and Banning, two new traffic lanes were built to form a four-lane highway, with dividing strip. The base consisted of selected material hauled from a creek by tractors and carrying scrapers, and fed automatically to an elevating-bucket line which conveyed it to the series of vibrating screens. From the bins it was drawn into a batch box, weighed by multi-beam scales and delivered to a 2-yd. mixer for a minimum mixing period of 45 seconds.

Approximately 90 percent of the pit material passed a 4-mesh screen, and to this was added 7 percent (by weight) of Portland cement, with 10 to 11 percent of water. The mixture was hauled to the road in dump trucks. A compacted thickness of 6 to 9 in. was required for the base, and owing to the high bulking property of the mixture it was necessary to spread it to a thickness of 14 in. to produce the compacted depth of 9 in.

After trying various methods of spreading and compacting the material on the subgrade, a bulldozer blade was equipped with steel wings extending forward 4 ft. from the ends of the blade, their forward ends being mounted on wheels and adjusted to the required elevation above grade. This worked well, except that owing to its mass the dumped material was more consolidated at the center than near the ends of the blade, which resulted in a crowned section after rolling. To eliminate this crown in the finished base, adjustable steel plates were placed along the bottom of the bulldozer blade, and were set to give a cross-section that would be even and of the required thickness after compacting. Trucks, while dumping, were pushed by the bulldozer and as much mix as possible was kept in front of the blade. Some hand shoveling was necessary to keep a proper amount at the blade ends.

Spreading was done for half the width and advanced 50 to 75 ft., after which the other half was brought up. Compacting was done at first with a sheepsfoot tamping roller, but owing to the high percentage of fine material in the mix, the tamping feet tore up the material. This work was then done by a 12-ton three-wheel roller following the spreader, and followed in turn by a motor grader having a 12-ft. blade. A 1,600-gal. tank truck with 12-ft. spray bar or pipe applied a fine spray of water to keep the exposed surface from becoming dry. In the finish rolling, tandem and three-wheel rollers caused surface laminations and were abandoned, the difficulty being overcome by truck rolling, using pneumatic tires and a slight excess of moisture at the surface. When laminations could not be eliminated by rolling, the high parts were cut off by a motor grader, the material being wasted.

Immediately behind the final rolling, a curing seal of liquid asphalt was applied, consisting of ½ gal. per square yard. This was done with a power spray and hand-operated nozzle. At first, the time required from leaving the mixing plant to the finished rolling was about three hours, but as equipment and handling technique were developed this was reduced to 1¾ hours. Oswald Brothers were the contractors, and J. M. Hollister was resident engineer for the California division of highways.

Experimental Barracks at Camp Grant

***Contents in Brief**—As an experiment in cost, appearance and utility, eight 63-man barracks were built at Camp Grant, Ill., of materials other than the standard wood design. Four are of two types of steel construction, two are concrete block with concrete floors and frame, and two are hollow tile with different floor systems.*

POSSIBILITIES FOR DEPARTURE from the standard wood frame, wall and floor construction for the 63-man barracks, built by the thousands in the first group of army camps, have been investigated at Camp Grant, Ill., by the construction of eight experimental barracks. Four of these buildings are all steel, of two types; two are concrete block with concrete frame, floors and roof; and two are of hollow tile, one with wood floors and interior frame, the other with steel inner frame, concrete and tile arch floors. From these eight unusual structures the army is obtaining information on costs, appearance and utility of materials other than wood for barracks construction.

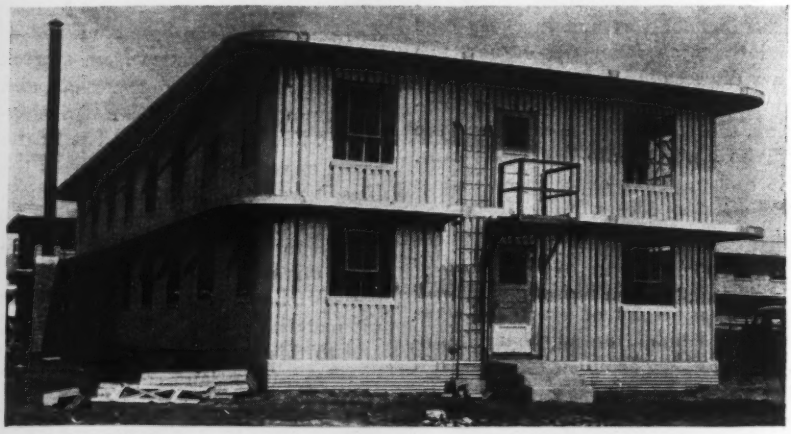
Complete cost data have not yet been compiled, and when they are available they will not represent costs on similar buildings built in any large quantity. The contractors were not organized to build these various types of buildings, and the construction procedure would be changed considerably resulting in lower costs, if any one of the eight types were selected for another job. This is especially true in the case of the four steel structures, supplied by two manufacturers who admit their costs could be greatly reduced in light of experiences at Camp Grant.

The experimental buildings were built to the standard two-story wood-frame barracks dimensions: 28 ft. 8 in. x 80 ft., with column or post spacing 10 ft. in the longitudinal direction and 9 ft. 5 in., 9 ft. 10 in., and 9 ft. 5 in. transversely. No doubt costs could be lowered by changing the dimensions and column spacing, especially in the steel design where the odd transverse column spacing complicated the framing, floor and wall panel erection.

The four steel buildings were furnished by two fabricators: H. H. Robertson Co., Pittsburgh, Pa., and Globe-Wernicke Co., Cincinnati, Ohio.

Robertson steel design

The two Robertson buildings are practically identical, except for a slightly different arrangement of the steel deck in the second floor. They are steel frame throughout. Posts or columns, extending from concrete footing to roof, are made up of four light channels welded together; floor and roof beams, connecting all columns at the two floor levels and the roof, are two 4-in., 5.4-lb. channels, welded back to back. Outside walls are 20-gage Robertson Galbestos cellular panels, full story height, with cells set in a vertical position and with a 20-gage interior sheet metal backing, made up in panels 2 ft. wide with interlocking sides. The inside surface of the exterior walls is faced with Masonite wall board. A 1-in. rigid insulation separates the panels and wallboard.



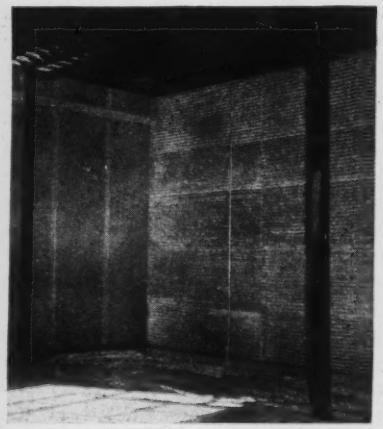


Fig. 1. Cellular exterior sheeting and round-corner flares give the Robertson steel barracks a distinctive appearance. The interior views show (left) lower story with cellular steel ceiling, wallboard finish of exterior wall and corrugated metal partitions; (right) second story of one building, where the cellular metal ceiling was placed flat side down.

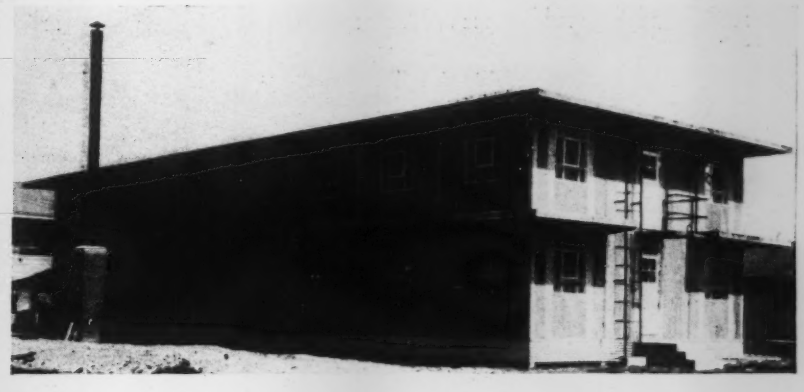


Fig. 2. Flat-topped Globe-Wernicke steel buildings are simple and attractive. Interior view shows rolled-beam frame, flat metal floor panels with wood surface, and wallboard finish of partitions.

Floors of the Robertson buildings consist of cellular steel sub-floors with cells turned down (except for the second floor of one building where the smooth surface is exposed as the first-floor ceiling) and carry a mastic on which is placed a parquet wood floor. The flat roof is 16-gage Robertson steel deck, 1-in. insulation and a built-up roofing. At the roof and second story levels the steel decks are cantilevered on steel brackets to form flares 3 ft. wide around all four sides of the building.

Interior partitions are wood frames of 2x4-in. studs, sheeted on one side with galvanized corrugated sheet metal, on the other side with wallboard. Windows are steel casement and all doors are wood although exterior doors are set in steel frames. The one set of stairs leading to the second floor is of steel, as are also the outside fire ladder and emergency exit platform at the second floor.

Globe-Wernicke design

Globe-Wernicke furnished two identical steel-frame, steel-clad buildings. Exterior columns are made up of two 3x1½-in. channels welded together. They carry outside floor and roof beams of 6x3½x½-in. angles. Interior columns are 6-in., 20-lb. wide-flange sections, supporting roof and floor beams of the same section, running in the longitudinal direction only. The steel framework is bolted together.

Floors and the flat roof are made up of steel panels, 12 in. wide, spanning transversely between the longitudinal beams. Panels at the roof and second floor levels extend 3 ft.

Fig. 3. Hollow tile barracks are only experimental units with a gable roof. A feature of one interior is tile-covered concrete beam and tile filler second floor (left) carried on Lally columns and steel girders. The interior view at right shows the clear-span second story of the wood-interior tile wall building.

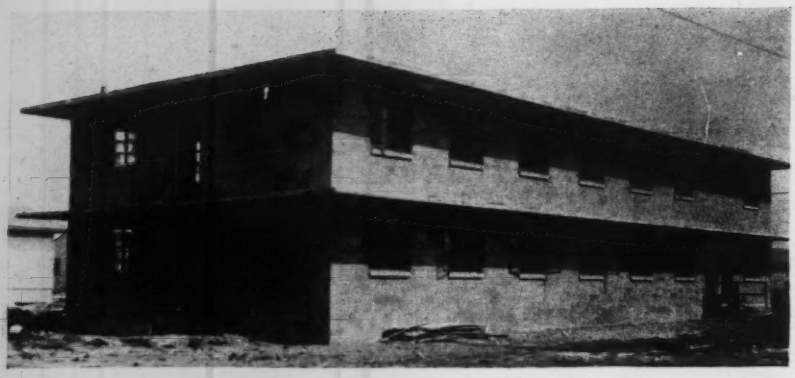


Fig. 4. Two of the barracks are all-concrete except stairs, windows and doors. Exterior walls and partitions are block, interior frame is concrete column and girder construction with flat slab floors.

beyond the walls as flares. The panels are 18-gage flat troughs, laid flat side down on top of the beams, and clipped together to form a solid deck. Their upstanding flanges are crimped inward at the top to receive a wood nailing strip that rests jointly on adjacent panels.

Exterior walls are of the same panel construction with the panel units set vertically, flat side out. Inside finish of the outside walls is two-tone wood fiber, with a 1-in. rigid insulation between steel panels and the wallboard. A single thickness of wood flooring is placed over the panel decks. The roof is insulated and carries a 3-ply composition roofing.

Partitions are of the same panel construction as the interior walls, finished on one side with wood fiber. All door frames, both interior and exterior, are steel, though the doors are wood. Windows are steel casement, and the stairs are steel. Fire ladders and exit platforms are also of steel.

Hollow tile

Two of the eight buildings are of hollow tile construction, one with concrete and tile floors, the other all-wood interior. In addition to the usual concrete piers, the foundations include a concrete wall around the entire building. Exterior walls are load-bearing hollow tile, 8x8x15¾ in. The outside face is wire cut, inside face is smooth, and no interior finish is used. The units were laid up with ⅜-in. joints, cells horizontal.

In one building the first floor is a 4-in. reinforced concrete slab on fill, carrying 2x3-in. wood sleepers, a subfloor and a wood finish floor. Support for the second floor consists of 3½-in. Lalley columns carrying 6-in. longitudinal steel beams. Spanning from wall to beam, and between beams in the center bay, is a series of composite precast concrete and hollow tile beams, the tile, 6x8x12-in., forming the lower part of the beam and exposed in the ceiling below. These transverse beams are 24 in. apart. Filling in between the beams are 12x4x24-in. hollow tiles. A 2-in. concrete slab covers the tile arch, and is finished off as the second floor.

Both tile buildings have a gable roof, made up of trusses of 2x6-in. joists and 2x6-in. rafters, 24 in. c.c., with a clear span over the second story. These are the only barracks, standard and experimental, where the second story columns are eliminated. To tie in the roof framework, and also the second floor tile and concrete framing, four courses of brick replaced the tile in the outer walls at the second floor and roof levels. The brick courses are hidden from outside view by sloping wood flares, ceiled at the bottom. The wood roof carries a prepared roofing.

Interior partitions in the concrete-floor building are smooth hollow tile. Windows are steel casement with concrete sills.

The exterior of the other tile building is similar in design, except windows are double-hung wood sash with concrete sills. The interior of the first story is standard wood barracks construction, with 6x6-in. posts and 6x8-in. sills supporting the second story floor of 2x10-in. joists, 24 in. c.c. The first floor has 2x8-in. joists, 20 in. c.c. Both floors have a subfloor with a finished wood floor.

Concrete block

The two concrete block structures are identical, except that cinder blocks were used on one, concrete on the other. Exteriors are load-bearing concrete block walls made up of 7¾x8x15¾-in. units left unfinished on the inside. Foundations include concrete walls for supporting the blocks. The first floor is a 4-in. concrete slab on fill, with a topping of wood sleepers, subflooring and finish wood floor.

The interior frame work consists of 8x8-in. concrete columns extending to the roof. At second floor and roof levels are 8x8-in. concrete beams, running in the longitudinal direction only. Second floor and roof are 4-in. flat concrete slabs spanning from walls to beams and between beams at the center bay. The slab is finished off for the second floor surface. The flat-slab roof carries a 1-in. cork insulation and a prepared roofing.

Interior partitions are 4-in. cinder block. Both buildings are equipped with steel casement windows with precast concrete sills.

Direction

The eight experimental barracks were designed by Holabird & Root, Chicago, architect-engineer for the construction of Camp Grant, with the cooperation of the two firms furnishing the steel structures. John Griffiths & Son Const. Co., Chicago, is general contractor. E. L. Deacon, superintendent. Major Howard Graham is constructing quartermaster in charge for the Army.

Combining Old and New in Sewage Disposal

Fig. 1. Architectural concrete is featured in the construction of the Bakersfield, Calif., sewage treatment works.

***Contents in Brief**—Using a recently developed combination flocculator-clarifier unit, which gives high efficiency in the removal of suspended solids, Bakersfield, Calif., supplements this pre-treatment of its sewage with broad irrigation. Thus the city secures complete treatment of its sewage, and at the same time irrigates 600 acres of pasture land.*

SOMETHING NEW AND SOMETHING OLD in sewage treatment methods were combined at Bakersfield, Calif., to give that city an efficient, economical system of disposal. Using the recently developed "clariflocculator" process for pre-treatment of sewage, the partly purified effluent is then piped to pasture lands, where the ancient but useful practice of broad irrigation is employed to assure complete treatment of the wastes without offense.

Clyde C. Kennedy, consulting engineer of San Francisco, who designed the plant, reports that the flocculator-clarifier unit has averaged more than 80-percent removal of suspended solids without the use of chemicals. The plant has a design capacity of 7.5 mgd. but to date the average rate of flow has not exceeded 5.5 mgd.

The effluent from the plant is disposed of by broad irrigation on 600 acres of land which is used for cattle pasturage. Says Mr. Kennedy: "The effluent is practically free of visible suspended solids, and under the conditions of operation of the irrigation system, no nuisance is created."

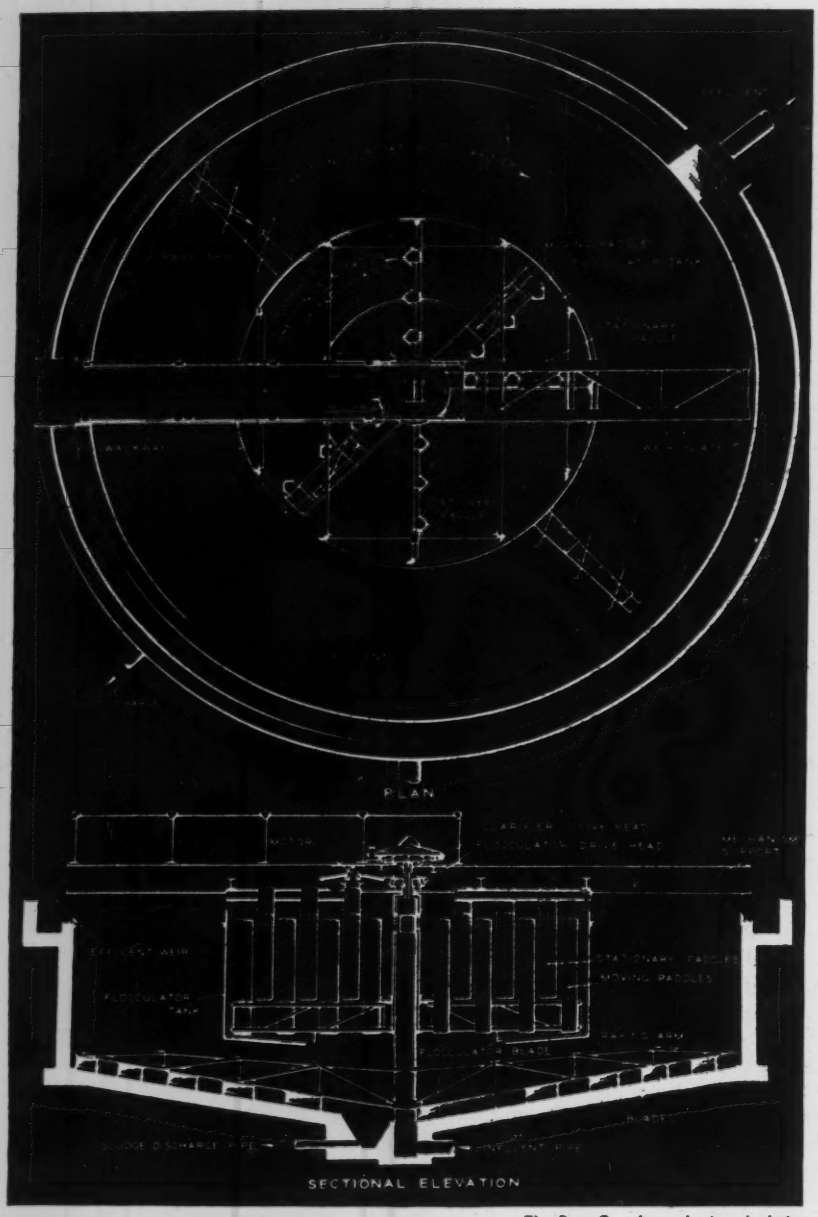
Treatment units for the plant include facilities for chemical coagulation, a single tank for combined flocculation and sedimentation; two-stage digestion tanks and sludge drying beds equipped with a conveyor-type mechanical cleaner.

In order of sequence of flow through the plant, the several structures are: bypass and flood control structures; screen and shredder house; grit detritor; Parshall flume; control building containing pump sump and pumping units; reaction tanks with chlorine solution equipment, gas burning water heater, water supply and circulation pumps, sludge pumps and laboratory. Provision is made for future installation of gas-engine-driven electric generators; another flocculator-clarifier unit; and additional sludge digestion tanks and sludge drying beds.

The invert of the sewage channel entering the control house is 15 ft. lower than the selected elevation for the clarifier overflow weir. The sewage sump has a 50-min. storage capacity of the average daily flow for temporary storage in the event of a power failure. The pumping plant is designed to operate automatically under the conditions of the varying rates of daily flow with the sewage level at all times below the half capacity of the sump. The pumps are the horizontal centrifugal type located in the pumproom adjacent to the sump with centerline of pump one foot above the bottom of the sump.

In the control building is installed a Scott-Darcey type chlorination unit for dosing the sewage with (1) ferrous chloride at the screen house or at the pump sump for odor control; (2) with ferric chloride in the line ahead of the flocculation-sedimentation tank for coagulation, and (3) with chlorine for conditioning the supernatant liquor from the sludge digestion tank and for terminal disinfection, when and if necessary. Also in the building are located the sludge pumps, hot water boiler, circulating pumps, fresh water pressure tanks and the flow recording gage and control board. Office and laboratory facilities are housed in the building on which glass brick has been employed to enhance its appearance.

The flocculator-clarifier unit is contained in a single tank, 100 ft. in diameter; a circular baffle divides the tank into two concentric compartments (see Figs 2 and 3). The tank, which has a center depth of 17.96 ft. and a side water depth of 10 ft., is provided with center feed and circumferential discharge facilities. The central zone or compartment, 50 ft. in diameter, is designed to operate as a flocculating unit and is equipped



The Dorr Co., Inc., chart and photo

with a paddle mechanism for this purpose. The annular ring compartment outside the flocculating unit is the sedimentation zone; this is equipped with a sludge scraping and skimming mechanism. Provision is made for adding ferric chloride to the sewage flow in the influent line when and if peak load conditions require chemicals for adequate solids removal. The use of chemicals has not been required, however, since the first period of operation.

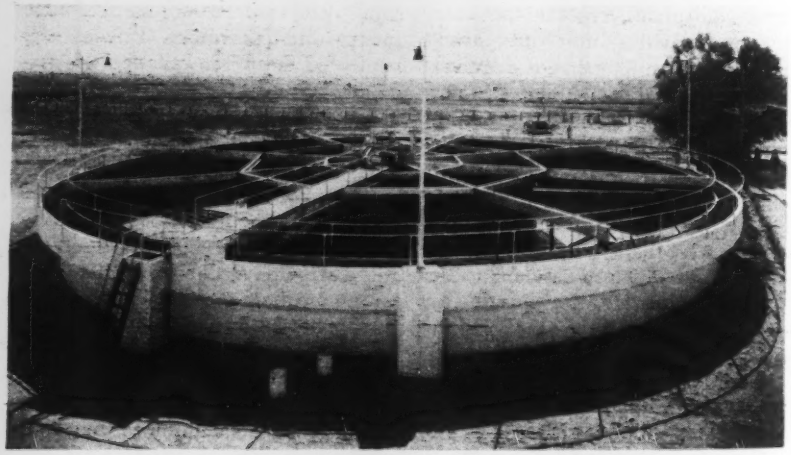
The digestion tanks are designed for two-stage operation with heating coils in the primary digester only. The tanks are each 45 ft. in diameter and 22 ft. deep with a gasholder on the secondary tank to provide for equalizing the gas flow. Interconnecting piping and valves for control of sludge flow are located in the valve house which connects the digestion tanks. All piping for sludge, water and gas is carried in a gallery between the digestion tank and the control building.

Supernatant liquor from the digester is conveyed to the pipeline leading from the pump to the flocculator-clarifier tank, and provisions are made to add chlorine in the line to condition the liquor if it should have a tendency to disturb the functioning of the settling tank.

The sludge drying beds are 25x100 ft. in dimension. They are provided with a motor-driven belt conveyor and loader which may be moved from one bed to another by means of transfer rails (Fig. 1).

The water supply for the plant is provided by a well equipped with an automatically controlled pressure system. The outdoor piping system includes provision for adequate irrigation of the ground.

A tank suspended within a tank separates the flocculation and clarification zones of the combination unit. The inner tank, with its slowly moving paddles, induces flocculation of solids; following this, sedimentation takes place in the annular compartment, which is equipped with sludge scrapers.



Flocculation and clarification processes are carried on in this simple tank, which is divided into two compartments by a circular metal baffle.

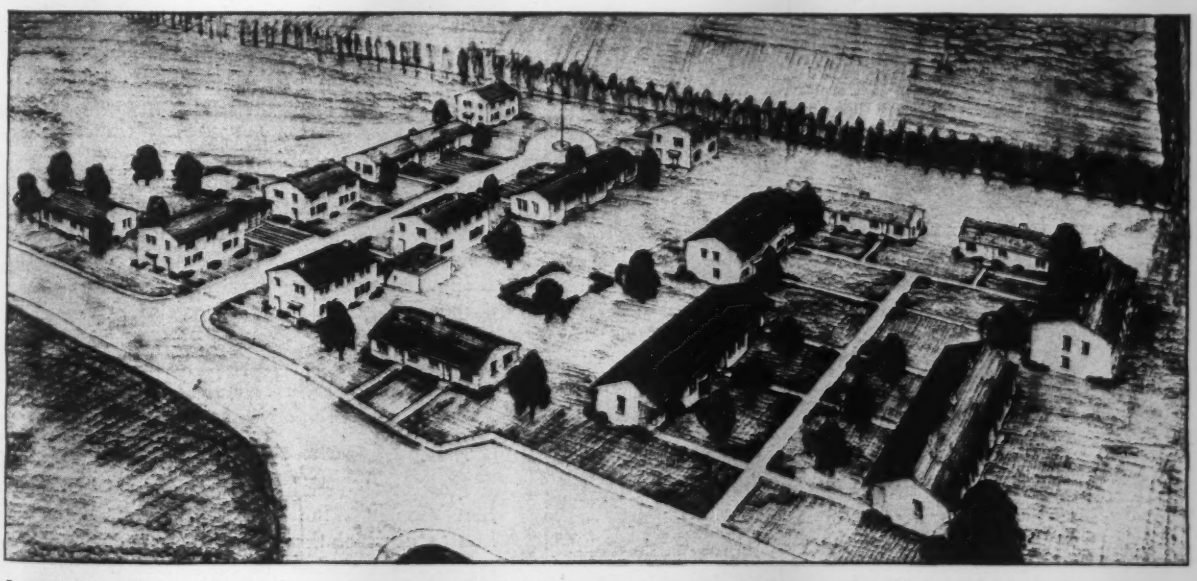
Houses Built in Jig-Time

Jigs for the prefabrication of house sections are laid out in assembly line fashion. All lumber is cut to size and panel units assembled at this "house factory" located near the site where defense dwellings are being erected.

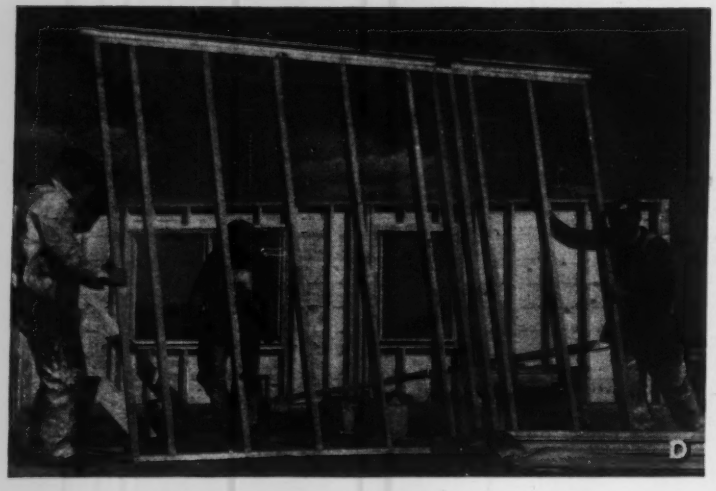
***Contents in Brief**—Prefabrication and a new idea in financing are the novel features of the 500-family Audubon Village (N. J.) defense housing project sponsored by the Federal Works Agency. Field erection of twenty houses a day (wood frame and plaster construction) was made possible by jig fabrication of panel sections and partitions in an assembly shop near the site. The sale or lease arrangement to shipyard workers known as the "Camden Plan," utilizes mutual insurance principles to provide low-cost home ownership.*

BIGGEST NEWS thus far in the defense housing program is the virtual completion of the first of three FWA projects to be built under the "Camden Plan." The project—Audubon Village, N. J.—is newsworthy and significant from two angles. Here a special division of the Federal Works Agency is introducing a new form of financing for large-scale housing by means of a mutual insurance plan; and at the same time the project is giving vivid demonstration of the possibility of mass production methods applied to wood frame house construction.

The story of Audubon Village (as well as that of FWA's Avian Village now under construction near Dallas, Tex., and a 700-family project planned for Clark Township near Linden, N. J.), goes back to November, 1940. At that time John M. Carmody, FWA administrator, called in Col. Lawrence Westbrook to talk about defense housing. Colonel Westbrook was an experienced practitioner in the field of low-cost housing. In fact, as assistant administrator in the Federal Emergency Relief Administration in 1934-36, it was he who fathered the idea of a rural rehabilitation program which led to the creation of the Resettlement Administration. Following this he engaged in private practice with cooperative housing developments in the Southwest. To Administrator Carmody he revealed a plan—a plan which involved in part principles employed by housing cooperatives in Europe and, with different applications, by mu-



Portion of Audubon Village layout, first of the FWA defense housing projects to be built under the "Camden Plan".



A—Foundation construction and floor framing on the site.

B—Panels for a complete house are unloaded from a truck adjacent to a completed foundation on which the rough flooring has been laid.

C—Section-built panel erection is started at one end of the platform.

D—Even the partition frames are pre-assembled to expedite erection.

E—Precision fitting and straight nailing assure strength in prefabricated parts.

tual insurance companies in this country.

The idea offered such promise that Colonel Westbrook was appointed immediately as a special assistant, and he was told to go to work on the problem of providing housing for CIO shipyard workers in the Camden, N. J., area. Meeting with the Housing Committee of the International Marine and Shipbuilding Workers' Union, Colonel Westbrook found that this group had independently arrived at some of the conclusions which he held. From this meeting there emerged the "Camden Plan." In essence it provides for federal government to furnish initial capital and build housing facilities, which are sold or leased under a rental system to people who become stockholders of a "mutual housing corporation." The latter assumes private control of the enterprise as soon as the federal government has acquired sufficient equity to protect itself from loss. Details of the plan are given in the accompanying panel.

Section-built houses

Most notable engineering feature of Audubon Village is the method of erecting the houses, of which there are 184 of six different types. Panel sections of the houses are prefabricated in a nearby shop, and then the

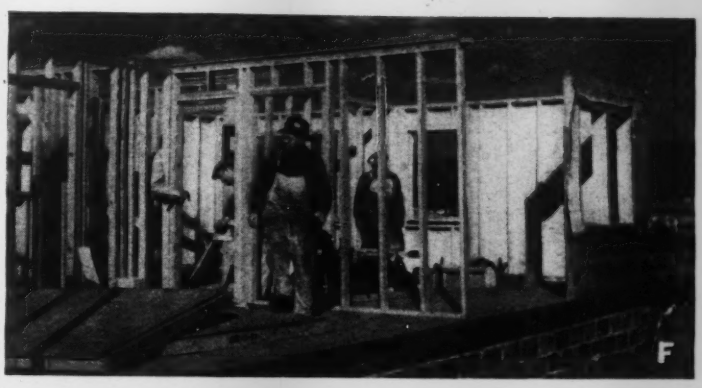
sections are assembled in the field on foundations previously constructed.

"The advantages of such a system of procedure," says Burns Roensch, FWA technical consultant for the project, "are self-evident. We wanted both speed and economy; speed to meet a 100-day construction deadline, and economy to keep the houses within the $3,000 per unit limit imposed by the Lanham Defense Housing Act."

Mr. Roensch points out that prefabrication operations could be started before the site was made ready, so that when the foundations were complete all was in readiness to assemble the houses—at a rate of twenty or more family units per day. Further, the shop fabrication method, using assembly jigs and lumber cut to exact dimensions with power saws, permitted efficient employment of unskilled labor and thus lowered cost of production.

Shop fabrication methods

The Wheeler Engineering Co., Inc., of New York City, which holds the $1,400,000 general contract on the houses, sublet the prefabrication work to Day Housing Corp. The latter, a newcomer in the prefabrication field, is headed by Joseph P. Day, the famous New York City real estate promoter. Fortunately,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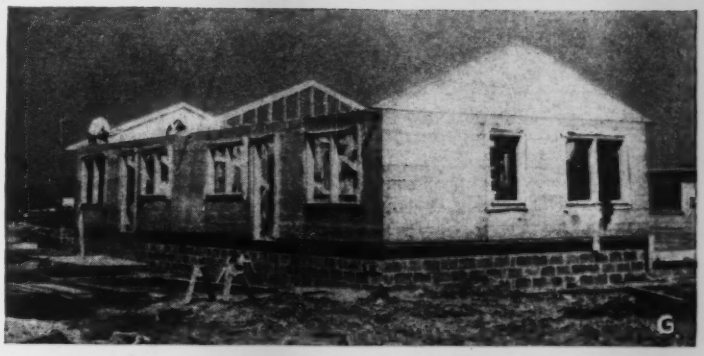
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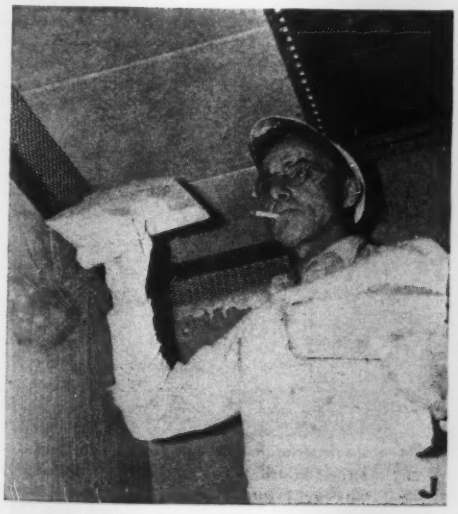

J

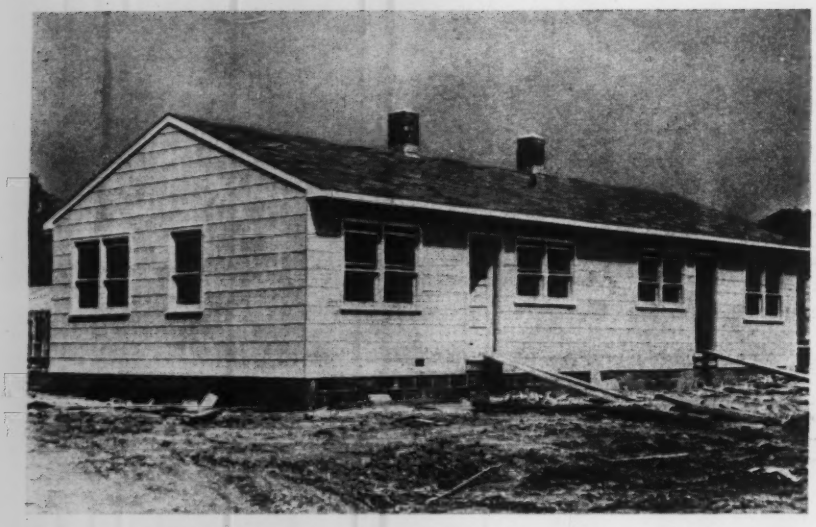
F—One side of the house is left open until all partitions are erected.

G—Roof truss and gables are fitted in place and ceiling rafters installed.

H—The roof, like the sides, is formed with section-built panels.

I—Asbestos-cement siding and asphalt composition shingles complete the exterior, and

J—Plaster board and two coats of plaster are used on the interior.



A two-family house nears completion. Each family dwelling includes a bedroom, combination living-dining room, kitchen, bath and a utility room.

an ideal plant suitable for assembly purposes was found just a few miles from the site of the village. The plant is an abandoned foundry at Gloucester, N. J., with a floor space of 110,000 sq.ft.

Here the lumber is brought by railroad cars, from which it can be routed to storage piles or directly to the saws. Six 14-in. circular swing saws, each manned by an operator and helper, are used to cut all the framing and boards to the proper length. Pieces of one size are stacked into piles from which a supply is drawn to serve the assembly lines. Incidentally, the amount of waste per house has been less than one-half of 1 percent of the lumber used for its construction.

The assembly lines for the fabrication of panels, shown in the picture at the head of p. 55, are nothing more than substantially braced wood frames. The frame, notched and blocked off in various places, is a jig into which can be fitted all the precut pieces of lumber to form a particular panel or section of the house. A "fitter" fills the jig with the proper pieces, after which a "nailer" fastens them together.

Then the precut wood sheathing is laid on the frame panel and nailed into place. The completed panel, about 8 ft. square, is now ready to be lifted off the assembly line onto a hand-pushed truck for transport to "make-up" storage. At the latter place huge truck trailers load up the various panels, roof trusses and ceiling rafters for one complete building. Trailers are so loaded that when they reach the erection site the material can easily be piled to the order in which it will be needed.

Average production at the Day fabrication plant is ten buildings per day, each building consisting of two family units. The assembly lines have an eight-hour production rate of 520 panel units. Saw operators, helpers and assembly men employed by the Day Corp. number about 150.

On the site

The site of Audubon Village is a 100-acre tract, trapezoidal in shape. The street and cul-de-sac layout are reminiscent of the Radburn and Greenbelt subdivision planning ideas; FWA calls this layout a "park living plan." The attractiveness of the plan is indicated by the first page illus-

THE CAMDEN PLAN OF RENTAL HOUSING

As explained to *Engineering News-Record* by Col. Lawrence Westbrook, special assistant to the Federal Works Administrator

• The mutual home ownership plan, popularly known as the "Camden Plan", was applied experimentally in the defense housing program in an effort to provide a pattern of housing—for use by private capital as well as by government—which might overcome some of the more serious defects inherent in home-ownership housing on the one hand and in rental housing on the other.

• Briefly, the plan provides for the sale or long-time lease of a complete housing project consisting of from 200 to 1,000 dwelling units to a mutual homes company, organized under state law. Originally the federal government will own all the stock of the company. Each acceptable applicant for a dwelling unit will purchase from the government stock equal in value to the dwelling to be occupied. The company will then enter into a "home security" contract with the resident stockholder in which the latter will agree to pay a monthly sum sufficient to take care of the following: interest, amortization, insurance, taxes, maintenance and repair, vacancy reserve, administrative expense.

• Of the above items the interest would be paid by the mutual housing company to the government. Amortization charges likewise would be paid to the government, and credited on the stock subscription of the resident stockholder. Insurance and taxes would be a fixed expense, the latter paid to the political subdivision having jurisdiction over the property. Repairs and maintenance would be estimated annually and any excess over actual expenditures would be credited to the individual reserve of the resident stockholder. Vacancy reserves would be credited likewise to the individual reserve of the resident stockholder. Administrative expense would be estimated on an annual basis and any excess over actual expenditures would go to general reserve.

• If a resident stockholder should vacate his premises and terminate his contract at any time within one year, all of his reserve credit would accrue to the general reserve. He would, in effect, be paying rent for the period of time that he occupied the premises concerned. After the expiration of one year an occupant terminating his contract would receive the following credits: 50 percent of the amount paid in by him for amortization; 50 percent of the net amount of his individual vacancy reserve after deducting any losses occasioned by actual vacancies; 100 percent of maintenance and repair reserve less actual cost of renovation; and 25 percent of his proportionate share of the general reserve.

• These procedures constitute a close analogy to insurance procedures. The latter provide that after a given length of time the excess reserve created by the periodic payment of insurance premiums constitute surpluses which may be safely credited to the policyholder. The policy has a cash surrender value or a paid up insurance value. It likewise has a loan value.

• Similarly, under the proposed Camden plan, after a sufficient number of periodic rent payments are made, the excess reserve may be paid out in cash when a member finds it necessary to surrender his contract or, if he finds that he is unable for a time to pay his periodic rental charges, he may utilize such reserves as paid up rent. Or he may borrow on them.

• Thus, it will be seen that the plan combines the advantages of housing through home-ownership with other advantages hitherto available only through renting. In effect, the occupant of a dwelling unit is a stockholder in the company which serves as his landlord. A mutuality of interest is thereby assured.

tration, reproduced from a sketch furnished by Hettel and Stonorov of Camden, N. J., associated architects on the project.

Paralleling one side of the site is the Blackhorse Pike, heavy-traffic outlet from Philadelphia to the New Jersey seashore. The "village" is about 2½ miles from the Camden shipbuilding shops, workers from which will occupy the houses.

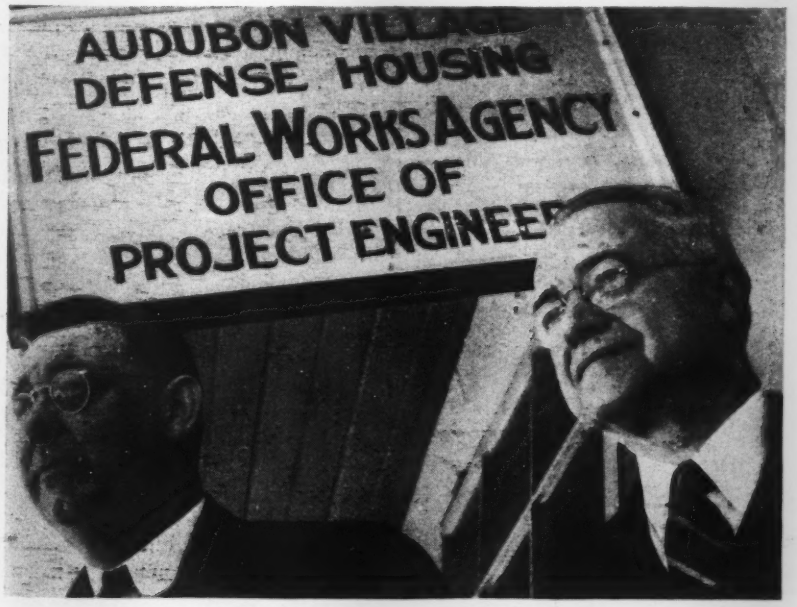
The big job of grading the site and installing utilities and roads, estimated to cost about a million dollars, was assigned to WPA forces. Using a crew of 400 men working in two shifts of 7 hours, and such equipment as 12 cu.yd. carrying scrapers, tractors, bulldozers and trench diggers, Supt. O. B. Blizzard started work on January 6 and pushed the job vigorously. At no time did his operations interfere with other construction. This tribute was paid by FWA engineer Isaac Harby, who shared with Arthur Sankey, assistant project engineer, the full responsibility of coordinating activities to meet the 100-day deadline on May 30.

Consulting his "diary," Mr. Harby states that the Wheeler Engineering Co. began excavation for the 184 houses on February 17, started foundations of the precast cinder block type on February 24, and completed this work on April 7. On April 9, with practically all of the rough plumbing completed, house erection began. Trucks started rolling in on that day from the fabrication plant, where assembly began on March 14.

Heavy construction equipment helped to convert a 100-acre farm tract into a 500-family community at Audubon Village.

The system of field erection, developed by Arthur Hamburger, president, and Jack Weigel, superintendent of the Wheeler Engineering Co., followed this schedule after the foundations and rough plumbing below the first floor were in.

1. Place floorbeams and framing, using precut, termite-treated lumber.
2. Place rough flooring and otherwise complete the "platform" for the erection of the house. At this time the brick chimney work is carried up to the ridge pole elevation.
3. Erect section-built panels and all prefabricated elements of the house.
4. Install all rough plumbing and electrical wiring above the first floor. At the same time, on the exterior, install asphalt shingles on the roof, rigid asbestos shingles on the sides, and complete brickwork on the chimney.
5. Apply plaster board and two coats of plaster on interior walls. The final coat being a buff-colored sand finish, the walls require no further treatment.
6. Install interior wood trim, finish flooring, hang doors and sash, and set plumbing and lighting fixtures. On the exterior paint all exposed wood portions.



Arthur Sankey and Isaac Harby, assistant and project engineer, can hardly believe their eyes as houses go up at the rate of one every half hour.

Using specialized gangs of workmen for each operation outlined above, an average of twenty houses per day have been erected. About 32 man-hours of labor are required for the field erection of a family unit using the section-built panels; this time is equally divided among carpenters and helpers. The total number of employees on various field operations, all of whom are affiliated with the American Federation of Labor, averages 850 daily.

From the experience gained at Audubon Village plus that obtained on the two similar projects now underway should come important findings on improved practice in housing construction. And finally, an opportunity has been afforded to make a practical study of the workability of the "Camden Plan" for financing large-scale housing developments.

Bracing—When and How Much?

H. S. Woodward
Structural Engineer, Larchmont, N. Y.

BUILDING CODES AND TREATISES give no attention to many bracing problems that arise daily in structural work, and every engineer therefore follows his own ideas of proper practice. Some rules applicable to at least the common cases would be valuable as a guide to good judgment. While every problem has individual conditions that must be weighed on the basis of mature experience, basic recommendations might well be established as a foundation from which to work.

Questions most commonly involved: When does a column need to be stiffened laterally and how strong should the bracing be? Should floor slabs be relied upon to brace a beam that carries a concentrated column load? When and how should the top flange of a beam be braced? They are illustrated by a few examples from current practice sketched herewith.

Bracing effect of floor arches

Figs. 1 and 2 illustrate a common problem, that of a column at a floor opening. This may be definitely settled by assigning a lateral force to be provided for in each direction, say a certain percentage of the column load. In Fig. 1, beam 1 would then be designed so that the end *A* would have adequate stiffness, and beam 2 would be proportioned and detailed as a brace beam. What lateral force should be used?

In fireproof construction the floor arches are usually relied on to brace the top flanges of the supporting beams. Just how far should this lateral support be considered adequate? When a beam carries a concentrated load (Fig. 3) is additional bracing advisable if the load is 25 kips? If the load is 100 kips? Would a straight tie to one or two of the adjoining beams be sufficient brace or should more rigidity be obtained? In other words what lateral force should be provided for?

Fig. 4 involves the same problem in different form. Here the stiffness of the cantilever beam is in question.

In a multistory building the columns adjoining the elevators are out of line with the other columns (Fig. 5). Are ties in the floor slabs (dash lines) necessary for a well integrated building?

Steel girders and wood joists

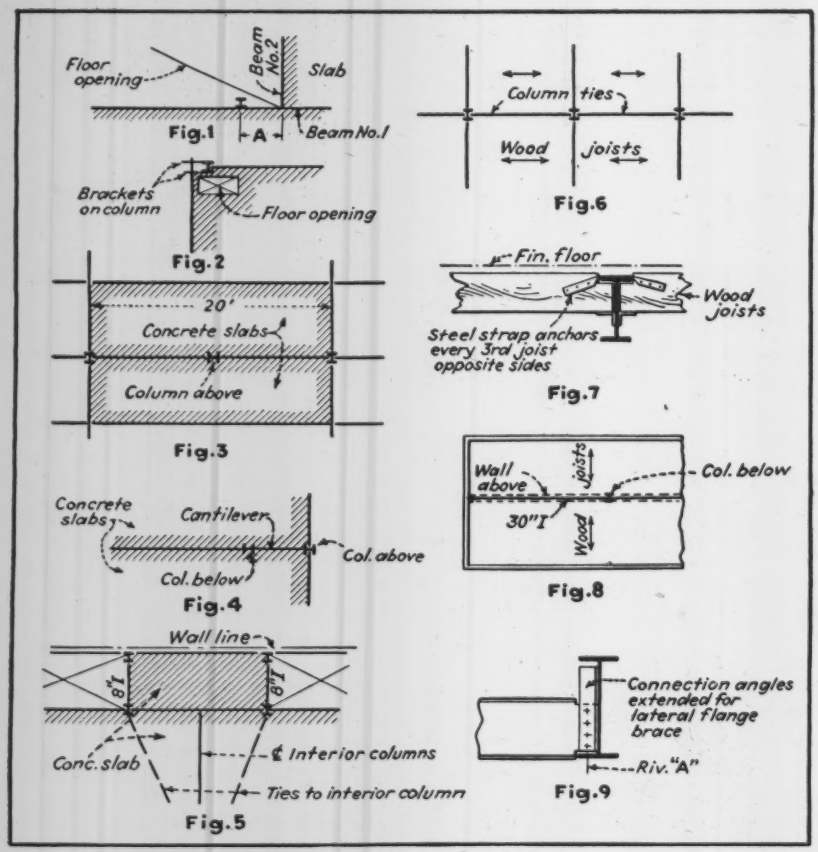
The question of what is an adequate tie arises typically in a non-fireproof building with steel girders and wood joists. Under the conditions shown in Fig. 6 many designers consider a tension member adequate. But the question arises, should the tie be designed for compression also?

Another bothersome bracing problem in wood-joist construction is connected with the joist anchorage to the girders, Fig. 7. With the standard type of anchorage sketched it is common practice to consider the top flange to be adequately braced; yet there must be a limit beyond which good judgment would dictate more positive bracing. Fig. 8 indicates a specific condition that presents this problem. Is positive top-flange bracing action possible here, or should the beam be figured laterally unsupported?

Knee-angle bracing of top flange

Top-flange bracing questions are often involved when beams and girders are framed with bottom flush. In Fig. 9 lateral support is given to the top flange of the girder by the connection angles of the beam, extended upward; should the rivets *A* be figured for moment due to flange bracing? If so, how much? And how far up the web of the girder should the connection angles extend?

The above are only a very few of the numerous problems that are of common occurrence. Every structural engineer knows of others. Discussion might be of considerable help in clarifying the questions involved and establishing a working basis for bracing design.



Figs. 1 to 9. Nine bracing problems from everyday practice invite discussion of where to use bracing and what lateral forces to provide for.

Engineering Aspects and Factors Of Fluorescent Lighting

BUILDING DESIGNERS' LIBRARY

Charles L. Amick
General Electric Co., Nela Park Engineering Dept.
Cleveland, Ohio

LIGHTING EQUIPMENT of the future, it has been prophesied, will be integral with the building which it illuminates. If history reveals such a prediction to have been true, certainly it will also record an increased dexterity on the part of engineers and architects to the point where they handle lumens and footcandles—light sources—and reflecting equipments with the ease now commonly displayed in the specification of building materials.

The most recent lighting tool is the fluorescent Mazda lamp. Introduced to the public three years ago, this revolutionary light source has enjoyed wide and rapid public acceptance. Because the choice of the illuminant, the selection of reflecting equipments and the satisfactory installation and maintenance of the lighting system are frequently the responsibility of the architect or engineer, a knowledge of the engineering aspects of fluorescent lighting must now supplement the well-known facts about filament lamps and lighting. It is the purpose of this presentation to supply this knowledge.

The lamp itself

Mazda F (fluorescent) lamps are electric discharge sources which emit light from their entire surface by internal fluorescence. The lamp consists of a tubular bulb with a filament-type electrode sealed in each end. Differing from an ordinary filament lamp in which current flowing through a solid tungsten wire heats it to incandescence, fluorescent lamps have no apparent electrical connection between the two electrodes. But when proper voltage is impressed on the lamp, current flows through mercury vapor contained within the tube. The result is a low-pressure mercury arc producing some bluish light but an abundance of short-wave ultraviolet energy which activates the fluorescent chemicals coated on the inside of the tube. Such chemicals absorb the invisible ultraviolet radiation and reradiate it at longer wavelengths. The remarkable efficiency of fluorescent lamps is due to the efficient conversion of electrical to ultraviolet energy which is in turn effectively transformed into visible light by skillfully blended fluorescent chemicals.

Presently available fluorescent lamps include nine sizes from 6 to 100 watts which meet the widest variety of lighting requirements. The choice of lamp dimensions and electrical values is determined not only by the maximum luminous efficiency, but by numerous other factors, such as adaptability to starting and operating on standard circuit voltages, suitable voltage drop and minimum wattage loss in ballast equipment, esthetically pleasing proportions, low surface brightness, etc.

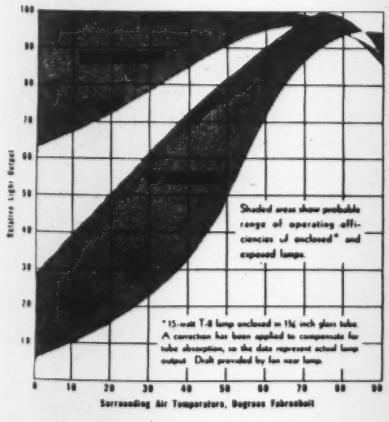
The accompanying table gives the dimensions and electrical data of the present line of Mazda F lamps, and the corresponding output in lumens for the sizes of lamps usually employed for general lighting. Generally speaking, efficiency increases with lamp length. However, efficiencies of certain sizes indicate that sacrifices were necessary to maintain acceptably low brightness with increased loading.

While the brightnesses of fluorescent lamps are low compared with those of filament lamps, they are still high enough to limit indiscriminate methods of application, particularly in areas devoted to seeing and selling tasks.

All Mazda F lamps are white when not lighted except the gold and red lamps which have an inner coating to produce the desired colors.

Auxiliary equipments

Fluorescent lamps, like all discharge sources, require specially designed auxiliary equipments consist-



Effect of surrounding air temperature and movement on the output of fluorescent lamps.

FLUORESCENT LAMP DIMENSIONS AND ELECTRICAL DATA

Lamp Watts[a]	6	8	14	15	20	30	40	65	100
Nominal Length, Inches.	9	12	15	18	24	36	48	36	60
Diameter, Inches.....	⅝	⅝	1½	1	1½	1	1½	2⅛	2⅛
Approx. Lamp Amperes.	0.15	0.18	0.37	0.30	0.35	0.34	0.41	1.35	1.45
Approx. Lamp Volts....	45	54	41	56	62	103	108	50	72
Circuit Voltages.....	110–125	110–125	105–125[b]	110–125	110–125	110–125 199–216 220–250	110–125 199–216 220–250	110–125	110–125 199–216 220–250
Rated Average Life, Hours[c].....	750	750	1,500	2,500	2,500	2,500	2,500	2,000	2,000

LAMP OUTPUT IN LUMENS

Color of lamp:									
White.....	180	300	460	615	900	1,450	2,100	2,100	4,200
Daylight.....	155	250	370	495	730	1,200	1,700	1,800	3,350
Soft White.....	.....	.....	325	435	640	1,050	1,500	.....	.....

Data as of April 15, 1941.

[a] Add auxiliary watts for total.

[b] Voltage range for two-in-series operation in which a specially designed filament lamp (60 volts, ½-ampere, S-11 outside-white bulb with intermediate screw base) is used as a resistance ballast. Total wattage of two lamps and ballast is 45 on a.c., 38 on d.c.

[c] Under specified test conditions.

ing of ballasts, starters, lampholders and starter sockets. The function of the ballast is to deliver the proper voltage and lamp current: one value for starting, another for normal operation. Actually, the ballast has a dual function: (1) to provide an induced voltage "kick" which starts the lamp when the starting switch opens and (2) to limit the arc current to the design value during normal operation. The starting switch momentarily closes and then opens the electrode heating circuit; automatic starters must close and open with reliable timing and pass enough current through the filament electrodes to preheat them sufficiently for quick and positive starting.

Early fluorescent auxiliaries had both ballast choke and starting switch in the same container but in the present system these components are separate items. Three general types of ballasts are available: (1) high power factor Tulamp ballasts, (2) high power factor single-lamp ballasts and (3) uncorrected power factor single-lamp ballasts.

Each fluorescent lamp requires a separate ballast, although the elements for two lamps may be in a single container.

Standard ballasts for 6, 8, 15, 20 and 65-watt lamps are designed for operation on 110-125 volt a.c. circuits, however, 30, 40 and 100-watt ballasts are available in three voltage ranges (110-125, 199-216 and 220-250).

Each fluorescent lamp requires an automatic starting switch. Many variations of such switches are possible, the most popular design for the smaller lamp sizes being a glow switch and radio interference condenser in a small aluminum can. The terminals are connected to each side of the lamp. Glow switch starters consume no energy during lamp operation. Four-contact thermal-switch starters have been developed for 65- and 100-watt lamps.

Operating characteristics

When operated from Tulamp ballasts, the light output of fluorescent lamps varies about one percent for each percent change in line voltage. The overall efficiency also decreases with increased line voltage. In the latter respect, filament lamps perform in an opposite manner.

Fluorescent lamps are designed to give the best all-round performance when operated within the design voltage range of the ballast. Since line voltage is a factor in starting reliability, it should be remembered that voltages lower than those recommended may result in unsatisfactory starting and therefore decreased lamp life. Other variables in starting reliability make it inadvisable to quote definite minimum starting voltages.

Lamps operate most efficiently at normal room temperatures of 70 to 80 deg. F. where the temperature of the glass tube itself has a value of 100 to 120 deg. F. The light output falls off somewhat with temperatures above 95 deg. but at temperatures below 65 deg. the decrease may amount to 1 percent per degree Fahrenheit or even more under draft conditions. The adverse effect of low surrounding air temperature (see curves) can be offset to a great extent by enclosing the lamps.

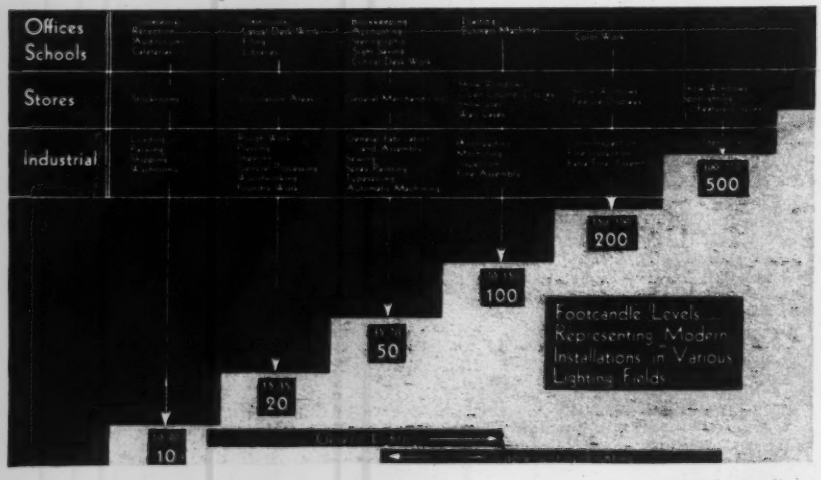
From the standpoint of starting and operation, no special restriction need be applied where surrounding temperatures are not below 50 deg. and providing the circuit voltage is within the required range. In most cases, satisfactory starting and performance should be obtained at temperatures considerably below 50 deg. by complying with the following:

1. Keep the line voltage up, preferably in the upper half of the ballast rating.
2. Conserve lamp by enclosure or some other suitable means.
3. Use starters which consistently provide higher induced starting voltages and longer electrode heating periods than are required for starting at normal temperatures. Special auxiliaries with thermal switches may well be considered for this service.

Fluorescent lamp ballasts are designed for indoor installation and should not be used when directly exposed to weather or where excessive moisture conditions prevail. Suitable ventilation should be provided so that the temperature around the ballasts does not exceed 120 deg. during normal operation. Other light sources or steam pipes adjacent to the ballast can raise ambient temperatures beyond this limit.

Characteristic transformer hum is inherent in lamp ballast equipment although the noise may vary considerably with individual ballasts. By mounting ballasts on soft rubber, fiberboard, or similar non-rigid mountings, the vibrations due to the magnetic action in the chokes will not be transferred to supporting members and disconcerting auxiliary hum will be reduced to a minimum. Such vibration insulation, however, should not inhibit heat radiation and transfer to the point where ballast ambient temperatures are exceeded.

The light output of fluorescent lamps closely follows the current wave and the rapid light variations cause a stroboscopic effect which may be annoying if viewing machinery in



Equal steps of modern lighting effectiveness in footcandles adequate for various requirements of office, school and factory.

operation or other rapidly moving objects. But when Tulamp ballasts are used the lamps operate out of phase and the fluctuation in light output is reduced—is then, in fact, comparable to low wattage filament lamps.

Additional ballast equipment in the form of series resistance is necessary if fluorescent lamps are to be operated on direct-current circuits. The resistance consumes about as much wattage as the lamp itself and thus the overall efficiency of light production on d.c. is only about one-half that of normal a.c. operation. Failure to provide the series resistance will result in the failure of either lamp or ballast.

Average life

In general, the more common sizes of fluorescent lamps have a rated average life of 2,500 hr. Like incandescent filament lamps, it is not unusual for some fluorescent lamps to fail after a few hundred hours while others may last 4,000 or 5,000 hr. to balance out the normal early failures.

Normal failure is due to the gradual dissipation of the electron-emitting material coated on the electrodes. This material is dissipated more rapidly during starting, although rated life should be obtained on the average if lamps are operated for normal periods of 3 to 4 hr. between starts. When this active material is used up the lamp will simply blink on-and-off, sometimes with a shimmering effect during the time that the lamp remains lighted. Most fluorescent lamps fail in this manner.

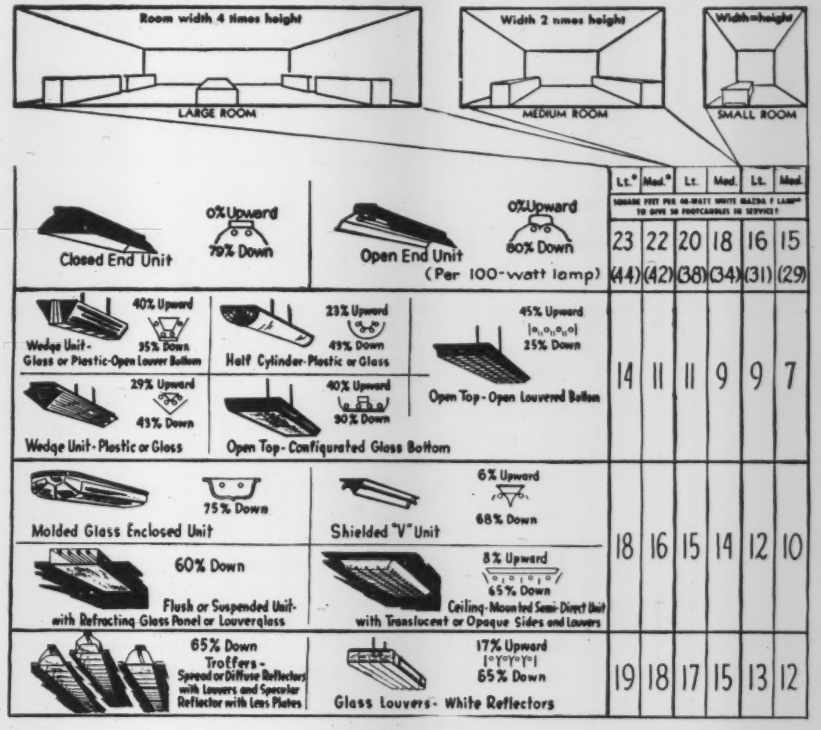
The light output at 100 hr. is used for rating purposes because the loss during this period may amount to as much as 10 percent. The average light output during life is about 90 percent of the 100-hour rating value.

The three colors of fluorescent lamps in common use for general lighting are daylight, white and soft white. The daylight lamp closely matches the color of overcast skylight and the white lamp is similar in color quality to filament lamps. The soft white is a relatively new color and is available for applications where a greater proportion of red is required.

One result of modern research in the science of sight is the principle that existing footcandle levels must be doubled to secure significant and measurable improvements in illumination effectiveness. The accompanying illustration shows this logarithmic progression. Illumination levels shown for various tasks represent those used in modern practice.

There is nothing mysterious about the light from fluorescent lamps and a great many of the early misunderstandings about this type of lighting would have been explained by the realization that a lumen is a lumen

GUIDE FOR ESTIMATING NUMBER OF MAZDA F LAMPS* REQUIRED FOR 50-FOOTCANDLE INSTALLATIONS†



Notes:

*Effect of Size and Color—
The light output of a 100-watt Mazda F lamp is approximately twice that of the 40-watt Mazda F size. This fact will affect the choice of the number of lamps per fixture or the number of fixtures. The illumination with "Daylight" lamps will be about 80 percent of "White" lamp illumination and with "Soft White" lamps about 70 percent of "White" lamp value.

† Average in Service, allowing for dust and depreciation of lamps and equipment. Initial values in a new installation will be substantially higher.

◆ Light Finish—reflection factor of ceiling 75 per cent; walls 50 percent.

● Medium Finish—reflection factor of ceiling 50 percent; walls 30 percent.

The factors in the table are based on performance of well-designed luminaires of the general types illustrated.

HOW TO USE THIS TABLE

Divide the total square feet to be lighted by the appropriate factor from the table above. The result is the number of 40-watt white Mazda F lamps required. The number of fixtures needed can thus be quickly calculated, depending on the number of lamps per fixture.

For example, if 4-lamp open top, open louvered bottom units are used to light a store 22 by 60 ft. with an 11-ft. ceiling and light walls and ceiling, the appropriate factor from the above table is the one for "medium room," with "light finish," namely 11. The procedure is:

$$\text{Number of lamps required for 50 footcandles} = \frac{22 \times 60}{11} = \frac{1320}{11} = 120$$

$$\text{Number of fixtures} = \frac{120}{4} = 30$$

The 30 fixtures should be located so as to give uniform lighting and a pleasing arrangement, which in the field of merchandising will frequently take the form of continuous rows. In the present example this would result in two rows running the length of the store.

whether it be a fluorescent lumen, an incandescent filament lumen or a mercury lumen. The fundamental concepts of illumination design remain unchanged regardless of the illuminant. The problem is still to determine how many of the lamp lumens will eventually reach the working plane and the well-established lumen method of illumination design can be applied with equal ease to fluorescent lighting.

In fact, the only way fluorescent lighting design differs from filament lighting is in the sequence of steps. In planning a filament-lamp installation it is customary to locate the outlets for uniformity of illumination and then use the lamp wattage size which will give the desired footcandle level. Because fluorescent lamps of different wattages are not interchangeable in fixed lampholders, the number of lamps required to produce the specified illumination level is determined and then the luminaires are spaced to give a pleasing arrangement. The allowable spacing for uniformity will probably not be exceeded although conventional spacing tables can be referred to in case of doubt.

Coefficient of utilization data on different types of fluorescent luminaries can be supplied on request by many of the equipment manufacturers. Since many present general lighting installations are going in at 50 footcandles or more, a simplified method of calculating the number of Mazda F lamps required for 50 footcandles is shown in the accompanying chart. This method of calculation is obviously of considerable benefit to the inexperienced lighting man.

Fluorescent Luminaires

While the bulb size, shape and light diffusion and distribution characteristics of the fluorescent lamp introduced new considerations in lighting practice which called for radically new designs of reflecting equipments, many types of luminaires have been developed and are now commercially available. Many varieties of semi-direct and direct-indirect fixtures give the illuminating engineer a wide selection. Newest of luminaire names is the "troffer," denoting a combination of trough and coffer in which continuous rows of fluorescent lamps are well shielded in louvered troughs recessed in the ceiling. For example, a fluorescent troffer can replace a row of acoustical material in the conventional suspended acoustical ceiling. Most of these troughs have used white porcelain enamel or lacquer but the latest method is to make the trough of a matte aluminum finish with a parabolic contour, which increases the comfort in the room by reducing the brightness of the troffer units.

Particularly effective results have been obtained in lighting industrial areas by mounting units end-to-end to produce the higher levels of illumination with minimum shadow. Such installations using continuous wiring channel permit a reduction in wiring costs.

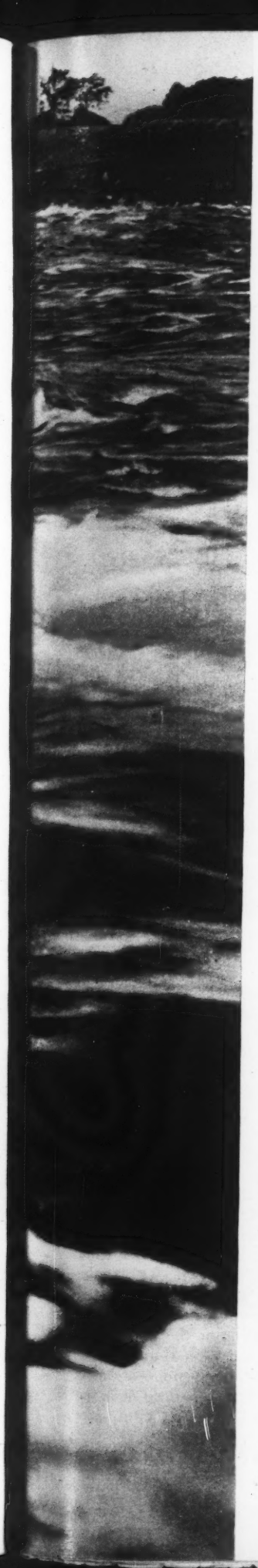
While Mazda F lamps, generally speaking, produce light about two and a half times as efficiently as do filament lamps, this does not mean that the lighting cost is comparably reduced. Actually, with all the factors considered the cost of good lighting with either filament or fluorescent lamps is about the same at the energy rates normally encountered. Whichever the light source, good lighting is inexpensive compared to the many benefits it brings.

Modern Drafting Room 300 Ft. Long

FLUORESCENT lighted and air conditioned, the modern drafting room occupying the second floor of the new office building at the South Philadelphia Works of the Westinghouse Electric & Manufacturing Co. is reported to be the longest unobstructed drafting room in any industrial plant—300 ft. long by 100 ft. wide. Housing about 600 engineering and office employees, the building is provided with these modern facilities: continuous-strip fluorescent lighting throughout; electro-static air cleaning as a part of the air conditioning system; sound-proof floors and ceilings; built-in bookcases located under the glass-block windows, which have double-pane "islands" of clear glass; complete sprinkler and emergency lighting systems. A 2-in. depth of water is maintained on the flat roof to dissipate sun heat during the summer by evaporation, and reduce the load on the air conditioning system.

The drafting room shown in the illustration has the highest illumination in the building, with an average intensity of 50 footcandles on the drawing boards. In the general offices the illumination measures 30 to 35 footcandles.

Under almost one-third of a mile of fluorescent lights, providing 50-footcandle intensity, these engineers are working in a 300 x 100-ft. drafting room. Note the raised position of the drafting boards, and the non-encased steel columns. In the upper left corner is one of the outlets for conditioned air.



DEVELOPING THE
St Lawrence
for Power and Navigation

Current plans to develop the international section of the St. Lawrence River appraised in the light of what has happened since such development was first proposed

An

ENGINEERING NEWS-RECORD

Report

MAY 22, 1941

Developing the St. Lawrence

V. T. Boughton
Associate Editor
Engineering News-Record

An agreement between Canada and the United States calling for completion of a 27-ft. seaway in the Great Lakes-St. Lawrence waterway system and for construction of power plants in the International Rapids section of the St. Lawrence River was signed on March 19. Approval of the agreement may soon be asked of Congress and the Canadian Parliament. In the pages that follow the history of the project is recounted briefly and the economic factors relating to the waterway and power project are reviewed.

FEW SUBJECTS have been the center of such long and involved discussion as has development of the international section of the St. Lawrence River for power and deep-draft navigation, a subject that again is brought into public discussion by the agreement signed recently by representatives of the United States and Canada. And because of the controversial nature of the subject, little of the great mass of literature relating to it is purely factual and free from being colored for or against the project. That makes appraisal of the proposed undertaking difficult, yet in view of the fact that Congress may soon be asked to put the new agreement into effect it is pertinent to review the history of the project and to set forth in as disinterested a manner as possible what now appear to be the significant elements of the seaway and power questions.

The St. Lawrence River

The St. Lawrence River between Lake Ontario and Montreal harbor has a length of 182 miles, a flow that averages around 237,000 cfs. and a fall of 224 ft. For the first 115 miles it forms the boundary between the United States and Canada, New York State lying along the south shore and Ontario to the north. Custom has divided this part of the river into two sections, the Thousand Islands section, embracing 67 miles of deep lake-like reaches from Lake Ontario to the first swift water at Chimney Point, and the International Rapids section, 48 miles of rapids and pools between Chimney Point and Lake St. Francis. The total drop in this latter section is 92 ft. As it enters Lake St. Francis the river leaves the border and passes into Canada. Below the border the river is divided into three sections: the Lake St. Francis section, 26 miles of deep water; the Soulanges section, embracing 18 miles of rapids between Lake St. Francis and Lake St. Louis; and the Lachine section, embracing Lake St. Louis and the Lachine Rapids down to Montreal harbor, a distance of 23 miles.

Early history

French-Canadian fur traders began to develop the St. Lawrence River and the Great Lakes for the movement of commerce more than 150 years ago. The rapids around which they first dragged their bateaux loaded with skins still are called by the French name "sault." In 1785 these traders built the first small wooden locks along the St. Lawrence River to get their bateaux around the rapids. Similarly, up at Sault Ste. Marie, where Lake Superior discharges its waters into Lake Huron, these same fur traders built the first wooden locks in 1795 to get their cargoes past the rapids without a long portage.

Traffic up and down the St. Lawrence to Montreal increased so rapidly that in 1804 the fur traders' locks were enlarged and then in 1825 a canal and new locks were built around the Lachine Rapids at Montreal to get vessels up to the mouth of the Ottawa. Above that point an easier route than the St. Lawrence was found by way of the Ottawa, consequently, for nearly 25 years river commerce moved by way of the Ottawa River to Ottawa and thence across to Lake Ontario through the Rideau Canal. From Lake Ontario up over the Niagara escarpment to Lake Erie private interests in Canada completed in 1829 a canal having 40 wooden locks 110 x 22 x 8-ft. deep over the sills. This was the first Welland Canal.

While this development was going on in Canada, the Erie Canal from Buffalo across New York State to the Hudson River at Troy was completed and put into service in 1825.

Twelve years after the completion of the first Welland Canal the government bought it, built stone locks of the same size but 9 ft. deep over the sills, and reduced the number of locks

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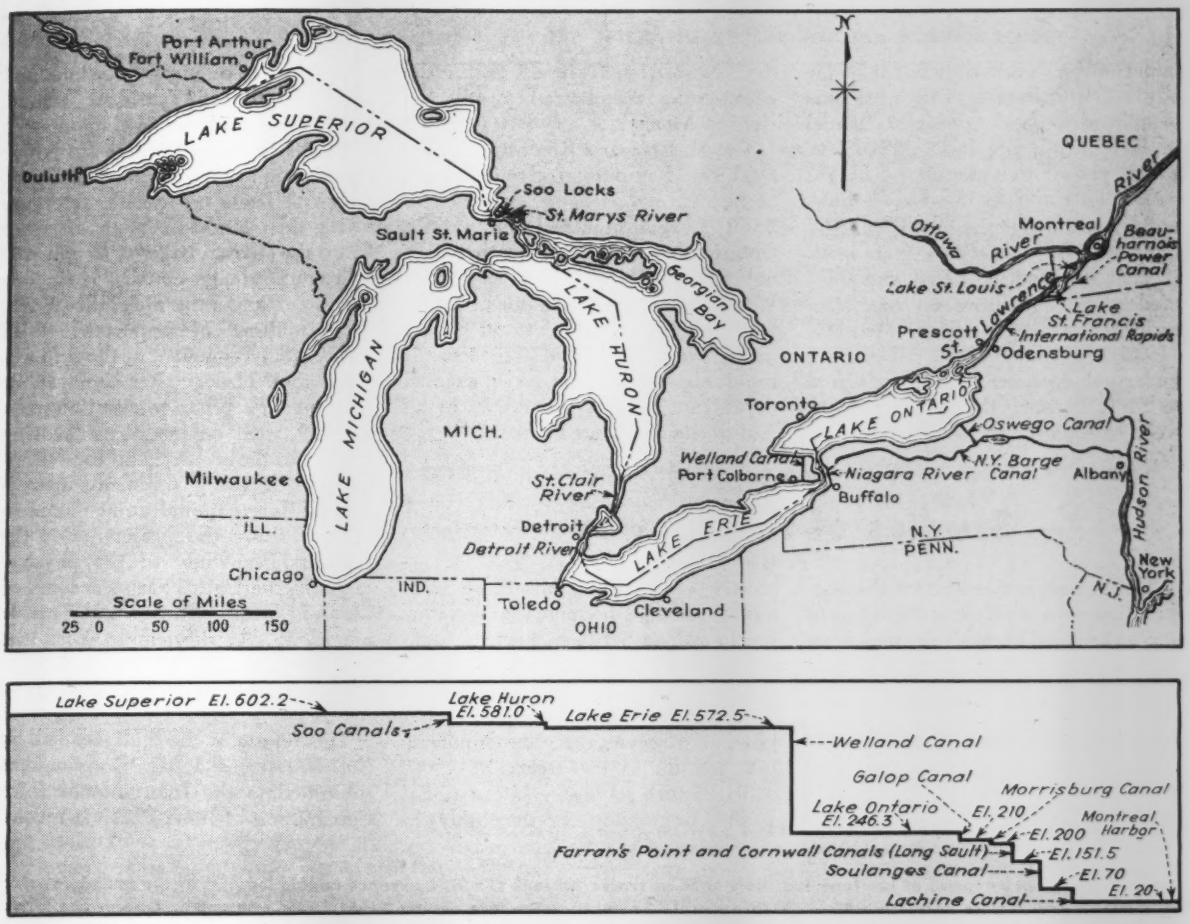


Fig. 1. Work in the Great Lakes-St. Lawrence system covered by the new agreement between Canada and the United States is concentrated largely in the International Rapids below Lake Ontario, where power plants and a 27-ft. ship canal are to be built. Canada agrees to deepen the Welland Canal and build new canals to replace the Soulanges and Lachine canals before the end of 1948 unless prevented by war conditions, and the United States will deepen the Great Lakes channels and build a new lock at Sault Ste. Marie. For details of the International Rapids, see Fig. 3, p. 828.

to 27. That canal was opened in 1845 and eight years later the lock depth was increased to 10 ft.

First ocean-going vessel

In the meantime redevelopment of the St. Lawrence River between Lake Ontario and Montreal was begun and in 1848 canals having locks similar to the Welland locks were put into service. In 1849 a schooner from Cleveland came down through the Welland and the new St. Lawrence canals to Montreal and from there sailed around Cape Horn to San Francisco, thus inaugurating the first passage of an ocean-going vessel.

Traffic through these canals increased, and with it came a demand for better facilities. In 1887 a new Welland Canal having locks 270x45x14-ft. deep over the sills was put into service and three years later canals of similar dimension around the rapids of the St. Lawrence were opened to traffic. In the same year the Northwestern Steamship Co. of Chicago placed a fleet of four steamers of 2,000-ton capacity in commission between Chicago and European ports.

Traffic continues to grow

Traffic through the Welland Canal amounted to 620,000 tons in 1887. By 1914 it had increased to 3,860,000 tons and Canada had begun the construction of the fourth canal at that point. Work on that canal was stopped during the first World War and it was not completed until 1931. The new Welland Canal has only eight locks and they are 859x80x30-ft. deep over the sills. It cost about $131,900,000.

Subsequent to opening of the Welland Canal, a deeper channel was dredged through the Thousand Islands section of the St. Lawrence River to permit the big grain boats to come down to Prescott, Ont., or to Ogdensburg, N. Y., where grain elevators were built for storage and transfer of grain to smaller boats on the St. Lawrence waterway or to railroad cars. Significant to the present discussion of the development of the St. Lawrence for larger ships may be the fact that despite this opening of Lake Ontario to the large boats that ply the upper lakes, few come down through the Welland Canal into Lake Ontario, preferring to discharge their cargoes at the lower end of Lake Erie at Buffalo or Port Colborne.

New York Barge Canal

While all this artificial waterway construction was in progress on the Canadian side of the border nothing was done on the United States side subsequent to the completion of the Erie Canal (1825) until New York

undertook to rebuild that canal for power-driven barges. That work was completed in 1919, giving a channel of 12-ft. depth and locks 328x45 ft., which permit the passage of barges 300 ft. long and 43 ft. wide. Following the opening of the fourth Welland Canal (1931), New York State modernized the Oswego Canal and built modern port facilities on Lake Ontario at Oswego. More recently (1935) the United States government undertook deepening the Barge Canal to 14 ft. between the locks from Oswego to Albany. It also has deepened the Hudson to 27 ft. so that large ocean-going vessels can go up the river to Albany.

The St. Lawrence River up to Montreal has a minimum channel depth of 32½ ft. and is being deepened to 35 ft. From Montreal up to Lake Ontario the controlling depth in the old side canals is 14 ft. The new Welland Canal has a depth of 25 ft. which can be deepened to 30 ft., the depth over the sills of the locks, if required. In the upper lakes, channel depths are from 21 to 25 ft. in all major channels and harbors.

Studies of the seaway

The present movement for the construction of a ship canal of sufficient size to let most ocean freighters come into the Great Lakes may be said to have begun with the appointment in 1895 of a Deep Waterways Commission. That commission was superseded in 1903 by the International Waterways Commission, but neither commission made much progress, due chiefly to the fact that there were many unsettled boundary and water-use questions between the two countries that were a constant source of irritation. Out of the deliberations of the International Waterways Commission, however, came developments that led up to the treaty of 1909, which in turn set up the International Joint Commission as the body to clear up the boundary questions and supervise the international waters. The 1909 treaty fixed the amounts of water that could be diverted for power on each side of the border at Niagara Falls but made no specific reference to the then large diversion of water from the Great Lakes through the Chicago Drainage Canal.

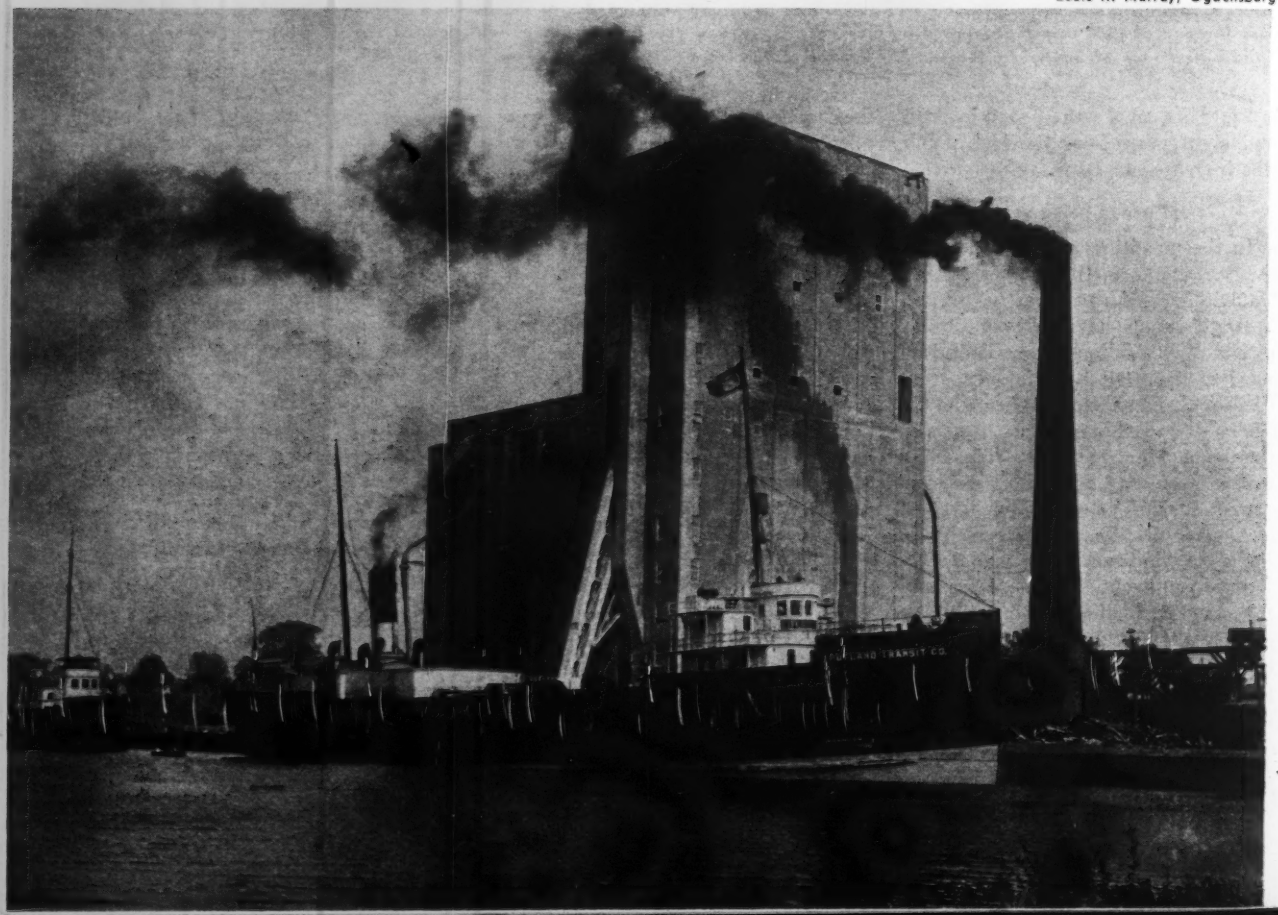
From 1909 until after the World War, nothing of importance with respect to development of the St. Lawrence took place. After the war, as grain exports began to rise Congress, in 1919, went on record as favoring a study of the seaway, and the following year the two governments instructed the International Joint Commission to study the project. For the commission's study of the physical features, the United States designated Lt. Col. W. P. Wooten and Canada named W. A. Bowden to head the engineering staff.

Wooten-Bowden report

The report of the staff headed by Col. Wooten and Mr. Bowden was submitted to the International Joint Commission in June, 1921. It recom-

Fig. 2. Small cargo vessel of the type that now handles traffic through the St. Lawrence canals loading at the grain elevator at Ogdensburg, lowest point to which the large grain boats that operate on the Great Lakes can come. One of the large boats is shown at the left. Larger grain handling and storage facilities are located at Prescott on the Canadian side of the river with direct rail connections to Montreal for winter movement of grain.

Louis R. Murray, Ogdensburg



mended the construction of a 25-ft. channel and the development of 1,464,000 hp. in the International Rapids (See Fig. 3.) at a total cost of $252,728,000. Increasing the navigable depth to 30 ft. was estimated at $17,986,000 additional. Details of the estimates made by these engineers are given in Table I.

The Wooten-Bowden report called for a combined navigation and power dam across the river at the Long Sault Rapids, with a power plant to develop 74 ft. of head located near the lower end of Barnhart Island, and a second dam at Ogden Island to raise the level about 8 ft. to provide navigation through the upper rapids and to insure suitable winter operating conditions through maintenance of an ice cover, ice being recognized as one of the major problems in the development of power.

Later in 1921 the International Joint Commission included these recommendations in a report to the two governments in which it recommended that a treaty to implement development of the river be negotiated and that in the meantime a larger board of engineers be set up to make fuller studies. No treaty came out of the discussion of this report, but in 1924 the engineering board was increased to six and became known as the Joint Board of Engineers.

Joint Board of Engineers

The Joint Board of Engineers completed its report in 1926. It covered improvement of the whole Great Lakes-St. Lawrence system. With respect to the St. Lawrence seaway, it recommended a 25-ft. channel with a 30-ft. depth in the locks, although the majority of the Canadian section favored an initial depth of 27 ft. in the waterway.

For power development in the International Rapids section this board proposed two schemes, a single-stage development favored by the American members, with a dam and powerhouse in the vicinity of Barnhart Island and with control gates at Galop Island; and a two-stage development, favored by the Canadians, the upper pool formed by a dam and powerhouse at Ogden Island, and the lower pool by a dam and powerhouses at Barnhart Island. The installed capacity in the single-stage development was put at 2,326,000 hp., and that of the two-stage development 2,215,000 hp.

TABLE I—COST ESTIMATES OF THE WOOTEN-BOWDEN REPORT—1921

River Section	Costs		Canal Maintenance	Horsepower	
	25-ft. depth (30-ft. locks)	Additional for 30-ft. depth		Initial	Ultimate
Lachine	$55,783,000	$12,944,000	$350,000	.....	860,000*
Soulanges	36,590,000	3,110,000	400,000	.....	1,560,000*
Lake St. Francis	1,158,000	662,000	30,000	.....	.....
International Rapids	159,097,000	1,270,000	305,000	1,850,000	.....
Thousand Islands	100,000	.....	20,000	.....	.....
Totals	$252,728,000	$17,986,000	$1,105,000	1,850,000	2,420,000

* Power in the Lachine section would cost $83,797,000 for 860,000 hp., and in the Soulanges section 1,560,000 hp. would cost from $124,468,000 to $151,688,000 depending on the type of development. When the report was written, 180,000 hp. was being developed by side diversions in the Soulanges section which would be absorbed in the projected overall development.

TABLE II—COST ESTIMATES OF THE JOINT BOARD OF ENGINEERS—1926

Single-stage development, 25-ft. depth of channel

River Section	Works for navigation	Works for power	Works jointly for power and navigation	Total cost	Horsepower
Lachine	$53,000,000	.....	.....	$53,000,000	*
Soulanges	31,594,000	$37,665,000	$34,686,000	103,945,000	404,300*
Lake St. Francis	980,000	.....	.....	980,000	.....
International Rapids	22,000,000	106,500,000	106,500,000	235,000,000	2,326,000
Thousand Islands	1,100,000	.....	.....	1,100,000	.....
Totals	$108,674,000†	$144,165,000	$141,186,000	$394,025,000	2,730,300*

* The Joint Board estimated that 2,498,000 additional horsepower could be developed on the Lachine and Soulanges section at a cost of $224,420,000.

† The added cost of a 27-ft. channel was put at $5,800,000.

This board set the cost of the two-stage development of the International Rapids at $264,600,000, which figure was raised to $274,742,000 for a 27-ft. depth by the reconvened board in 1932. The reconvened board made no revised estimate of the cost of the single-stage development.

TABLE III—COST ESTIMATE OF THE ENGINEERING REPORT OF 1941

River Section	Works for navigation	Works for power	Works jointly for power and navigation	Total cost	Horsepower
International Rapids	$38,578,000	$96,804,000	$130,788,000	$266,170,000	.....
Totals	$38,578,000	$96,804,000	$130,788,000	$266,170,000	.....

TABLE IV—DETAILS OF THE COST ESTIMATES OF THE 1941 BOARD

(Controlled Single-Stage Project, El. 238-242)

(A) Works solely for Navigation			
Upper Pool — at Point Rockway		$7,497,000	
Lower Pool — Opposite Barnhart Island		31,081,000	
			$38,578,000
(B) Works primarily for Power			
Structures, Head and Tailrace Excavation		$46,476,000	
Machinery and Equipment		50,328,000	
			96,804,000
(C) Works common to Navigation and Power			
Channel Excavation		$48,136,000	
Ice cribs above Prescott and above Galop Island		656,000	
Iroquois Point Dam		7,310,000	
Dikes		12,374,000	
Supply channel and weir at Massena		2,363,000	
Diversion cut through Long Sault Island		2,569,000	
Main Long Sault Dam		20,055,000	
Guard Gate, 14-ft. Lock and Weir at Maple Grove		2,624,000	
14-ft. Lock and Dikes at Iroquois		604,000	
Railroad relocation		3,696,000	
Clearing pool		518,000	
Rehabilitation of Morrisburg		5,024,000	
Rehabilitation of Iroquois		3,379,000	
Acquisition of lands, etc., U. S. side		4,657,000	
Acquisition of lands, etc., Canadian side		14,011,000	
Highway relocation		2,812,000	
			130,788,000
Grand Total			$266,170,000

The Canadian section favored the two-stage development as it required less flooding of agricultural and urban areas along the river and made possible the development of power at the upper site at an earlier date than would be possible with the single-stage development, thus aiding in development of a market.

Cost of the single-stage development was put at $235,000,000 and of the two-stage development at $264,600,000. These figures are for the work in the International Rapids. Figures for the complete single-stage development to Montreal, comparable to those of the Wooten-Bowden report are given in Table II.

Reconvened board report

In 1931, following a discussion between President Hoover and the Prime Minister of Canada of a waterway treaty, the Joint Board was reconvened to review its recommendation and estimates. It agreed at that time to the two-stage development favored by Canada and revised its estimate of the cost to $543,429,000 for the entire work from Lake Ontario to Montreal.

Treaty of 1932

In July, 1932, a treaty between the United States and Canada was signed. It called for a 27-ft. navigation channel with 30-ft. locks, a two-stage development for power, with dams at Crysler and Barnhart Island, an installed capacity of about 1,100,000 hp. for each country. The total cost from the Great Lakes to Montreal was put at $543,429,000 and, by giving Canada credit for work already done on the Welland Canal, the division of new costs was put at $258,453,000 for the United States and $142,976,000 for Canada. These costs to the federal governments were expected to be further reduced by contributions from the Canadian provinces and from New York for power facilities.

Also included in the treaty were provisions for construction of compensating works for control of the levels of the Great Lakes and possible future changes in diversions for power.

This treaty was the subject of extended discussions in the Senate. Among the principal objections to it were the following: that it made the Chicago diversion subject to international control (which the 1909 treaty had carefully avoided), that the division of costs was inequitable, and that the treaty called for expenditure of American money in Canada. In the end the treaty was rejected by the Senate, but not until 1934.

A new treaty was discussed in 1936, but the plans came to naught. Early in 1938 the Canadian government asked for an agreement that would authorize Ontario to increase its diversion around Niagara by an amount equal to the amount it diverted into Lake Superior from the tributaries to Hudson Bay, but that request was rejected by the U. S. Government on the ground that piecemeal revision of the 1909 treaty was undesirable. Secretary Hull said that the interests of the two countries would best be served by a new treaty covering joint development of the undeveloped resources of the Niagara and St. Lawrence rivers.

Engineering board named

An exchange of views followed and both countries named engineers to a board to bring the studies of the St. Lawrence up to date. That board was made up as follows:

Canada

Guy A. Lindsay, engineer-in-charge, General Engineering Branch, Department of Transport.

Olivier O. Lefebvre, vice-chairman, Quebec Streams Commission.

Thomas H. Hogg, chairman and chief engineer, Hydro Electric Power Commission of Ontario.

M. C. Hendry, assistant engineer, Hydro Electric Power Commission of Ontario.

United States

Brig. Gen. Thomas M. Robins, Assistant Chief of Engineers.

Roger B. McWhorter, chief engineer, Federal Power Commission.

Gerald V. Cruise, executive secretary and acting chief engineer, Power Authority of the State of New York.

In November, 1940, because of a great increase in power demands in

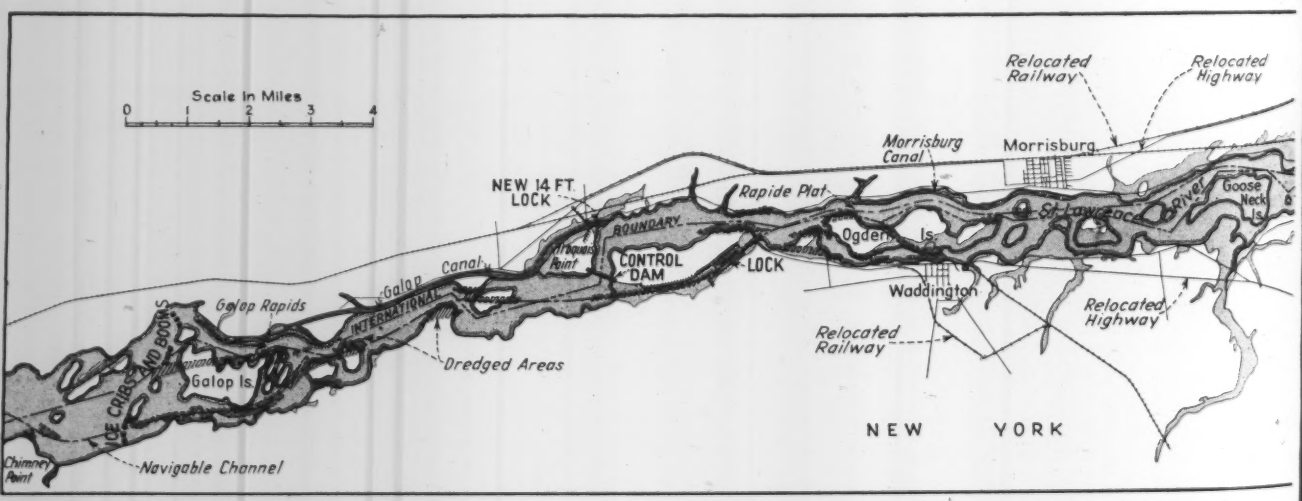


Fig. 3. Between Chimney Point, at the left, and Cornwall, at the right side of the opposite page, the St. Lawrence River falls 92 ft., largely in the Long Sault Rapids, shown in the picture on p. 823. Navigation uses the small canals along the Canadian shore, having to negotiate 12 locks. In the proposed development the flow from Lake Ontario will be controlled by

Canada due to war activities, the U. S. Government agreed to a temporary increase of 5,000 cfs. in the Canadian diversions at Niagara. At the same time it was announced that President Roosevelt had appointed the St. Lawrence Advisory Committee to collaborate with a committee to be appointed by Prime Minister King in drafting plans for an agreement under which development of the international waters could proceed.

The St. Lawrence Advisory Committee consists of Leland Olds of the Federal Power Commission, chairman, A. A. Berle, Assistant Secretary of State, Brig. Gen. Thomas M. Robins and Gerald V. Cruise. Prime Minister King appointed the following to the Canadian Temporary Great Lakes-St. Lawrence Committee: Guy A. Lindsay, Thomas H. Hogg, Olivier O. Lefebvre and J. E. Read, legal adviser, Department of External Affairs.

On Oct. 31, 1940, the Corps of Engineers set up the St. Lawrence River District with headquarters at Massena, N. Y., to continue the St. Lawrence studies and to supervise further exploratory work along the river, the President having allocated $1,000,000 to that work from the defense funds. The office is in charge of Lt. Col. A. B. Jones, district engineer.

Consulting engineers amployed by the district engineer are L. F. Harza, John P. Hogan, F. H. Cothran, Wm. P. Creager and Joel D. Justin. Irving B. Crosby is consulting geologist.

The Power Authority of the State of New York has opened an office at

TABLE V—EXISTING CANALS ALONG THE ST. LAWRENCE RIVER

Canal	From	To	Length	No. of Locks	Minimum Dimensions
Lachine	Montreal	Lachine	8.74	5	270x45x14 ft.* deep
Soulanges	Cascade Point	Coteau Landing	14.67	5	280x45x15 ft.
Cornwall	Cornwall	Dickinson's Ldg	11.00	6	270x44x14 ft.
Farran's Point	Farran's Point		1.28	1	800x50x16 ft.
Morrisburg	Rapide Plat	Morrisburg	3.89	2	270x45x14 ft.
Galop	Iroquois	Cardinal	7.36	3	270x45x14 ft.

* Depths occasionally less due to low water.

MAIN FEATURES OF THE CONTROLLED SINGLE-STAGE PROJECT
(See Fig. 3 for location of the structures)

1. A control dam in the vicinity of Iroquois Point.

2. A dam in the Long Sault Rapids at the head of Barnhart Island and two powerhouses, one on either side of the International Boundary, at the foot of Barnhart Island.

3. A side canal, with one lock on the United States mainland to carry navigation around the control dam and a side canal, with one guard gate and two locks, on the United States mainland south of Barnhart Island to carry navigation from above the main Long Sault Dam to the river south of Cornwall Island. All locks to provide 30-ft. depth of water on the mitre sills and to be of the general dimensions of those on the Welland Ship Canal. All navigation channels to be excavated to 27-ft. depth.

4. Dikes, where necessary, on the United States and Canadian sides of the International Boundary, to retain the pool level above the Long Sault Dam.

5. Channel enlargement from the head of Galop Island to below Lotus Island designed to give a maximum velocity in the navigation channel south of Galop Island not exceeding 4 ft. per sec. at any time.

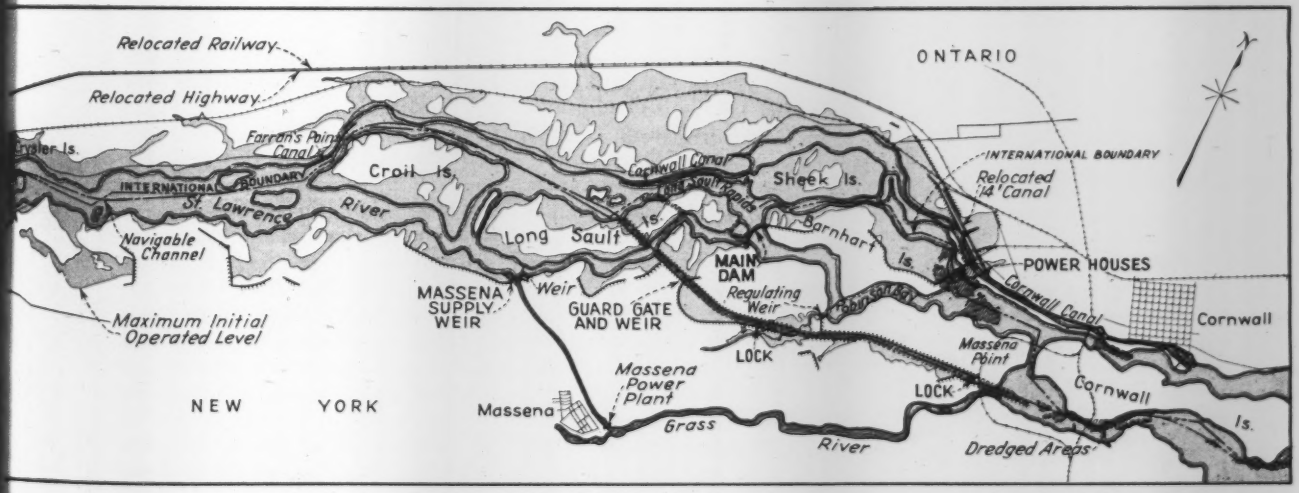
6. Channel enlargement between Lotus Island and the control dam and from above Point Three Points to below Ogden Island designed to give a maximum mean velocity in any cross-section not exceeding 2¼ ft. per sec. with the flow, and at the stage, to be permitted on Jan. 1 of any year, under regulation of outflow and levels of Lake Ontario.

7. The necessary railroad and highway modifications on either side of the International Boundary.

8. The necessary works to permit the continuance of 14-ft. navigation on the Canadian side around the control dam and from the pool above the Long Sault Dam to connect with the existing Cornwall Canal.

9. The rehabilitation of the towns of Iroquois and Morrisburg, Ontario.

All the works in the pool below the control dam shall be designed to provide for full Lake Ontario level, but initially the pool shall be operated at elevation 238.0.



a low dam at Iroquois Point. The main dam will be at the upper end of Barnhart Island and the powerhouses at the lower end of the island where they can be built across the international boundary. Three locks and a guard gate will be required for the new canal. Areas flooded by the new dams are shaded, and areas to be dredged are cross-hatched.

Watertown with Wm. T. Field as resident engineer.

Agreement of 1941

The agreement signed in Ottawa on March 19 of this year provides for the complete development desired by the U. S. Government. It calls for development of the International Rapids section of the river along lines that do not depart materially from the single-stage development of the Joint Board of Engineers. The new structures are shown in Fig. 3. A 27-ft. navigable channel is specified, with 30-ft. depths over lock sills. The locks and channels will be chiefly on the American side. Booms for ice control are to be provided near Chimney Point, there is to be a control dam at Iroquois Point and a main dam across the Long Sault near the upper end of Barnhart Island and a dam and powerhouses across the north channel at the lower end of the island with the powerhouses on each side of the international border.

Also included are dikes, railroad and highway relocations and the construction of new lock and channels in the 14-ft. canal to permit that canal to be kept in service.

In addition to this work in the international section of the St. Lawrence the treaty provides for much-needed remedial works to distribute the flow above Niagara Falls and for an increase of 5,000 cfs. in the water diverted on each side of the border at the falls for power. This may be further increased following completion of the remedial works if study shows that to be possible without harmful effect on the falls.

Chicago diversion

The agreement—like the proposed treaty of 1932—brings the Chicago diversion into international agreements for the first time and apparently fixes it at the present amount of 1,500 cfs., making any change subject to arbitration if necessary.

Ontario's diversions of water from the Hudson Bay drainage basin into Lake Nipigon and Lake Superior are recognized, Ontario to be granted the use of an equivalent amount of water at all points along the border where power can be developed (See *ENR*, April 24, p. 599).

Each government agrees to build all works within its own borders in the International Rapids section or an equivalent proportion of the works, but the United States agrees to provide "*funds for all construction, including design and supervision, of all works in the International Rapids Section, except machinery and equipment for the development of power and works required for rehabilitation on the Canadian side.*" The United States also agrees to do all the necessary work in the channels above Lake Erie to provide for 27-ft. navigation through the Great Lakes.

Canada agrees to deepen the Welland Canal to 27 ft. and to complete not later than Dec. 31, 1948, the 27-ft. waterway in the Canadian sections of the St. Lawrence River. Included in the latter is construction of new locks and canals in the Lachine and Soulanges sections. Completion may be expedited or postponed if war conditions make that necessary.

No work looking toward a deep waterway has been done in the Lachine section, but in the Soulanges section the Beauharnois Power Co. has dug an intake canal that must be deepened at the power company's expense when needed for navigation purposes. Substantially all that is needed in addition to the dredging to put it into service are guard locks, the main locks and changes in the bridges.

Cost allocations

The manner in which costs are apportioned between the two countries is most easily understood by an examination of Table VII. The only reference to the allocation of costs in the agreement is contained in the italicized quotation given above. As a compilation of the best available costs estimates shows that $277,000,000 is allocated to the United States and $132,000,000 to Canada there is good reason to surmise that when the agreement was drafted no cost figures were included in the hope that the unequal distribution would not be made an issue in Congress as it was in the past. After allowing Canada a credit of $132,000,000 for the Welland Canal, there is a balance of less than $13,000,000 in Canada's favor.

On the day that the international agreement was signed, the Canadian Government entered into an agreement with the provincial government of Ontario whereby the latter will pay to the Canadian Government over a period of years a total of $64,125,000 for all Canadian power works and lands connected therewith. This is to pay for works that actually will be paid for by the United States. hence the Canadian Government's outlay will be cut to $68,000,000. If Quebec takes over the Beauharnois development, the Canadian Government has agreed to pay the province $7,972,500. This is 37½ percent of the estimated cost of the works common to power and navigation already built in connection with the Beauharnois development, which percentage was determined upon as being the amount properly chargeable to navigation in working out the agreement with Ontario with respect to the proposed works in the International Rapids.

There is every reason to expect that the investment by the United States Government will be cut by purchase of power facilities on the New York side by the state of New York. When the 1932 treaty was under discussion an agreement was reached between engineers of the War Department and the Power Authority of the State of New York whereby New York would assume the cost of power facilities on its side of the border at an estimated cost of $89,726,750. Attempts to get that agreement approved as an amendment to the National Recovery Bill were defeated in the Senate. A similar agreement is now under discussion. If approved it would cut the cost to the United States Government to around $187,000,000 as against Canada's net cost of $76,000,000 after completion of the payment to Quebec.

Notable omissions

The 1941 agreement is more notable for what it omits than for what it includes. It makes no provisions for a change in the unequal division of water diverted at Niagara for power purposes, nor does it set up any control over the export of power from one country to the other.

Diversion for power purposes at Niagara under the 1909 treaty total 56,000 cfs., of which 36,000 cfs. is diverted on the Canadian side and 20,000 on the American side. About 10,000 cfs. of the Canadian diversion is used in the old Rankine station of the Niagara Falls Power Co., and half of the output of that plant (about 60,000 hp.) is exported to the United States. Another 60,000 hp. is exported to the U. S. under a long-term contract held by the Ontario Hydro-

Electric Commission. The total exported power is equivalent to about 8,500 cfs., hence the beneficial use is about equally divided, but there is nothing in the present agreement to make Canada's continued use of an excess of 16,000 cfs. contingent on continued export of an equivalent amount of power. Likewise, there is nothing in the agreement to cover the large amount of surplus power that now is exported to the United States in the Niagara District, which now exceeds one billion kilowatt-hours.

The original draft of the present agreement called for "equal and equitable diversion and efficient utilization" of the Niagara waters, but the agreement as signed eliminated the word "equal" and says "efficient utilization and equitable apportionment" of the waters. Equalization of the present diversions would cut diversions on the Canadian side to 28,000 cfs., which with the 5,000 cfs. of Hudson Bay waters allocated to Canada and one half the 10,000 cfs. increase authorized after remedial works have been built above the falls would give Canada a net gain of only 2,000 cfs. That would not be popular in Ontario, hence omission from the agreement of a requirement that the division of water used for power be equal may well be deliberate to help get support for the agreement in Ontario.

Although equal division of the present diversions does not appear to be advantageous to Canada, it is to be assumed that in such a division the 10,000 cfs. now used in the relatively low-head Rankine plant at the falls (owned by the Niagara Falls Power Co.) would be allocated to the Ontario Hydro Commission for use in an overall development similar to the Queenston plant. Thus, while the actual increase in flow available for power production on the Canadian side would be small, the net increase in power would be large.

Export of power

Power companies in Quebec also export large quantities of power to the Aluminum Company's plant at Massena, N. Y., a movement of power over the border that should be recognized if the agreement is to be freed from the effect of adverse legislation on either side of the border.

Omission of any specific provision for control of the movement of power across the border is notable in the light of what the United States Government said on power export in 1938 to support its rejection of Canada's proposal for piecemeal revision of the 1909 treaty. "While sympathizing with the desires of Ontario and Quebec [to find a profitable outlet for whatever power may be available to them in excess of actual requirements] the government of the United States considers that its primary obligation is to view the problem in terms of protection for the general power market in the United States and for those American industries which might become dependent upon imported supplies of power. The government is convinced that the question of power interchange across the border . . . should be dealt with as part of a general settlement of the problems of the entire Great Lakes-St. Lawrence Basin."

TABLE VI—ESTIMATED COST OF GREAT LAKES-ST. LAWRENCE SEAWAY—1941

(Navigable channel 27 ft. deep)

	Canada	United States	Totals
Great Lakes Section:			
New lock at Sault Ste. Marie		$8,000,000	$8,000,000
Connecting Channels		66,029,500	66,029,500
Welland Canal	$131,900,000		131,900,000
St. Lawrence River:			
Thousand Island Section	772,000	516,000	1,288,000
International Rapids Section;			
A. Works solely for navigation		38,578,000	38,578,000
B. Works primarily for power	25,164,000	71,640,000	96,804,000
C. Works common to navigation and power	22,414,000	108,374,000	130,788,000
Lake Section St. Francis	1,330,000		1,330,000
Soulanges Section	25,785,000		25,785,000
Lachine Section	55,839,000		55,839,000
Totals	$263,204,000	$293,137,500	$556,341,500
Expenditures to date	$131,900,000	$17,105,485	$149,005,485
Cost to complete	$131,304,000	$276,032,015	$407,336,015

TABLE VII—COST ALLOCATIONS UNDER 1941 AGREEMENT*

Section	United States	Canada	Total
Lachine — Soulanges		$82,954,000[3]	$82,954,000
International Rapids	$218,592,000[3]	47,578,000[3]	266,170,000
Welland Canal		1,100,000[3]	1,100,000
Niagara remedial works	838,450[3]	838,450[3]	1,676,900
Great Lakes Channels	49,372,000[3]		49,372,000
New lock, Sault Ste. Marie	8,000,000[3]		8,000,000
Totals	$276,802,450	$132,470,450	$409,272,900

* This table is not official. It was prepared by *Engineering News-Record* from the best available cost estimates, as indicated in the footnotes.
[1] Report to the Canadian House of Commons, March 21, 1941.
[2] Cost estimates of the Engineering Board of 1941.
[3] Canada-Ontario Agreement of 1941.
[4] Estimates of the Chief of Engineers, U. S. Army.

New cost estimates

When the agreement of March, 1941, was made public it was accompanied by a report of the new engineering board containing revised estimates of the cost of work in the International Rapids Section of the St. Lawrence. A summary of the estimates is given in Table IV. Notable in these estimates is the fact that "Engineering and Contingencies" is figured at 25 percent instead of 12½ percent in the report of the reconvened Joint Board of Engineers. This is understood to be due to uncertainty as to the trend of construction costs and to a proposed acceleration of the construction program, the board having concluded that the "construction program can be arranged so that delivery of power can be begun and navigation provided within four years of the time when active work is initiated, time being an essential factor in the emergency." The Joint Board of Engineers considered that from seven to eight years would be required after active work started.

Power development plans

The power plants, dams, dikes and all other structures on which the engineering board based its estimate are designed so that ultimately the full head from the level of Lake Ontario (El. 246.3) can be developed in the Barnhart Island powerhouses, but in the initial stages of power development the pool back of the Barnhart Island is to be maintained.

at El. 238.0. Subsequently it will be increased to El. 242.

Two powerhouses are to be built, one on each side of the border, and each containing 18 equal units, a total of 1,100,000 hp. in each country. The units are to be rated at 61,000 hp. each at the point of best efficiency under 81-ft. head and will be designed to deliver at least 10 percent in excess of this rating at full gate opening. The head with the pool at El. 242 will be 85 ft. and the turbine capacity will be increased.

Benefits to navigation

Whether the large investment called for in opening the Great Lakes to ocean-going vessels of 25-ft. draft will result in commensurate benefits to the two nations is a question that cannot be answered affirmatively or negatively with any assurance of accuracy, particularly at this time when the world's foreign commerce and shipping is going through an almost cataclysmic change due to the war. However, there are certain aspects of the shipping situation that appear to be significant and so warrant consideration by those who attempt to appraise the present proposal to build a St. Lawrence seaway.

In any appraisal the first thing to be recognized is that little of the available information was prepared by disinterested parties. Most published material is highly colored for or against the project. And in any appraisal of those statements the seaway question cannot be divorced from the power question because opposition to the seaway often is used as a smoke screen for opposition to public development of the river's power resources.

Opening of the St. Lawrence to ocean-going shipping has always been a favorite subject for the perennial waterway enthusiasts who see in it a means for moving the products of the Middle West to the markets of Europe. Their claim that the seaway will expand and improve the markets of the Middle West has built up wide support for the seaway among the grain-producing states of this country and the prairie provinces of Canada.

Opposition to the seaway comes from the railroads, the port cities of the Atlantic seaboard and from states served by the waterways of the Mississippi valley, from the coal-producing states and, indirectly, from the power companies and lake carriers. Buffalo, New York, and Montreal, the chief present points of transshipment, have always opposed the project.

Despite the pessimistic predictions of opponents of the seaway, traffic up and down through the antiquated locks and canals of the St. Lawrence has continued to grow at a fairly steady rate. The great bulk of this traffic is between Canadian or American ports on the Great Lakes and the port of Montreal or between the lake ports and ports along the Canadian and American Atlantic seaboard. Up until the European war broke out wheat and corn were the principal commodities moving down the river, and gasoline, oil, sugar, wood pulp and pulpwood, coal and iron ore were the principal upbound movements. Most of the grain was transshiped at Montreal for export to Europe. Raw and processed wood pulp came chiefly from Scandinavian countries, Quebec and the Maritime provinces, hard coal came chiefly from Welsh mines, soft coal from the Maritime provinces or from the Pennsylvania fields, ore came from the Maritime provinces and oil from the American oil fields.

Shipments of wheat and corn fell off more than 1,500,000 tons in 1939. This was offset by a heavy movement of soft coal from the United States fields down the canal and an increase in the coal moving up from the Canadian Maritime fields to Canadian ports. Coal shipments reached a record figure of 2,435,000 tons in 1940, and the combined movement of gasoline and petroleum products totaled just over 1,000,000 tons.

Freight traffic through the St. Lawrence canals reached a record high of 9,236,318 tons in 1938, and declined to 8,341,065 tons in 1939. Figures for 1940 are affected by the European war, being down to 7,479,617, according to the Canadian Department of Transport. The Dominion Bureau of Statistics reports that during 1938, 128 vessels with cargoes

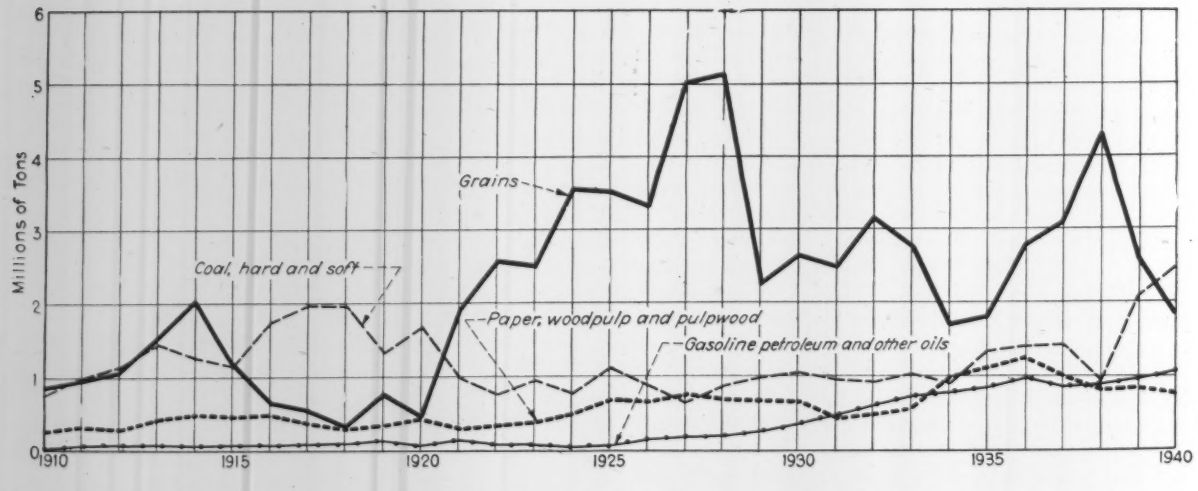


Fig. 4. Grain shipments made up the bulk of traffic through the St. Lawrence canals until 1928, except during the World War, and still maintain the lead, but petroleum products, paper and pulpwood, and coal, together, now make up the bulk of the traffic. A curve showing total traffic is included in Fig. 5.

totaling 211,208 tons were reported upbound through the St. Lawrence Canal from European, Newfoundland, Canadian and United States Atlantic ports. In addition to these, there was a considerable tonnage of coal from British and European ports transshipped at Montreal and forwarded by water, mainly to Toronto.

The U. S. Department of Commerce in *The St. Lawrence Survey*, Part II, states that in the same year 58,418 long tons of freight were exported in light-draft ocean-going vessels directly from the United States to Scandinavian countries and north German ports. There was one departure for a Black Sea port. In that year, 56,952 tons were imported to the Great Lakes in these same vessels from the United Kingdom, Baltic, Scandinavian, and North German ports, and one vessel from the Caribbean.

Future traffic

When the waterway was under study by the Department of Commerce back in 1927, the department estimated that 23,000,000 tons might be expected to move through a modern ship canal along the St. Lawrence, of which 80 percent represented exports and imports as distinguished from internal traffic. The Great Lakes-St. Lawrence Tidewater Association, the principal advocate of the project at that time, estimated the potential traffic as 30,000,000 tons. Estimates much lower than either of these figures were made by the Brookings Institution in its careful study of the project (*The St. Lawrence Navigation and Power Project*) published in 1927. The Brookings report placed the total foreign and domestic traffic at 10,563,000 short tons.

Setting this 1927 estimate of 10½ million tons over against the actual traffic of nearly 9¼ million tons in 1938 may be taken as indicating either that there is little need to build a new canal, as the present canal is handling most of the available traffic, or that the Brookings staff greatly underestimated the potential traffic and that the Department of Commerce estimate was more nearly correct. The latter appears to be the more likely as many exceptions to the findings of the Brookings report have been taken by careful students of the subject since it was published, all tending to show that the authors gave greater weight to the unfavorable factors than to the favorable factors.

Of the available indicators, the grain export curves reproduced as Fig. 6 appear to be most significant especially in the light of what is taking place in Europe. Export grain from the ports of Montreal and New York, which always has made up the great part of the potential traffic for a St. Lawrence ship canal, gained steadily until 1928, since when it has declined until in 1939 it was back to about the 1911 figure. American grain now has to meet competition in the European markets from Argentine, Australia, India and Russia. That such competition will be sharpened as an aftermath to the European war seems obvious.

Domestic movements

Also significant is the increase in domestic movements through both the St. Lawrence canals and the New York State barge canals, commerce between Canadian and U. S. ports. These indicate that the continuing growth in traffic moving from the lakes down to the seacoast, despite the decline in grain movement, is due to growth in a type of traffic that does not necessarily need a deep-draft canal. Modernization of the present St. Lawrence canals might serve such traffic adequately at a considerable saving in cost. Deepening the New York canal to Oswego and increasing the bridge underclearances is now in progress.

Advocates of the St. Lawrence seaway now look on domestic traffic from Detroit, Chicago and other industrial centers on the Great Lakes to ports of the Atlantic seaboard and even to the Pacific Coast as a major source of traffic. They cite automobiles as one of the principal commo-

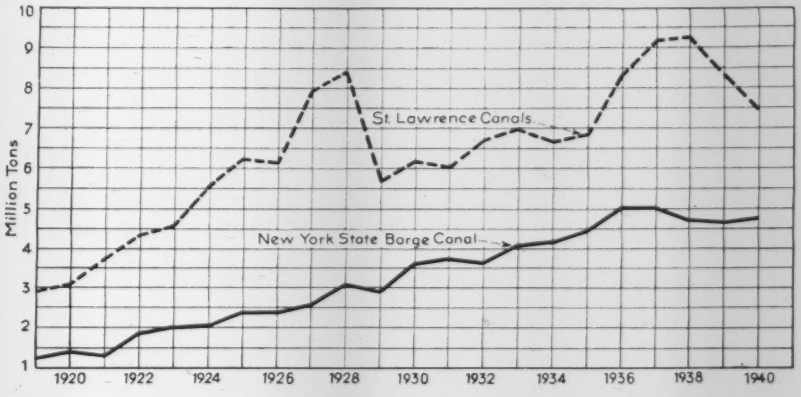


Fig. 5. Growth of traffic in the New York State Barge Canal has closely paralleled that in the St. Lawrence canals. Nearly half the tonnage in the Barge Canal is petroleum and its products. This chart is from the 1940 report of the Superintendent of Public Works of New York.

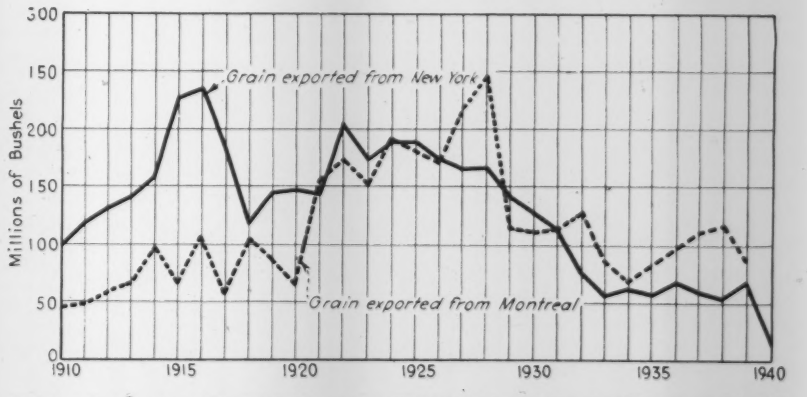


Fig. 6. Grain export through the ports of New York and Montreal increased fairly steadily until 1928, since when it has declined more rapidly. Montreal took the lead as the world's greatest grain port in 1927 and has maintained that position most of the time since then. The great part of the grain comes into Montreal by rail from ports on the lower lakes.

dities that will benefit through being able to move by the St. Lawrence route without transshipment.

Because of the great cost of each added foot of draft, the question of depth has been one of the major controversial points in past discussions. Opponents to the project, by including all the big trans-Atlantic liners in their totals for potential shipping, were able to show that a depth of 25 ft. or even 27 ft. would exclude a large part of the world's ships. Proponents, by including only cargo vessels, were able to make a much better showing. Figures compiled recently for *The St. Lawrence Survey* by the U. S. Maritime Commission show that the world's merchant fleet as of Dec. 31, 1939, included 9,200 vessels of 52,000,000 gross tons. Of these, freight ships numbered 6,403 with 30,000,000 tons, of which 71 percent of the vessels and 59 percent of the tonnage could navigate the 27-ft. waterway. Such a waterway would accommodate 65 percent of the freighters in the U. S. share of the total and 56 percent of the tonnage. However, in view of the enormous destruction of the world's shipping that is taking place at the present time, all estimates of what part of the world's shipping could use a 27-ft. waterway become quite meaningless.

American ships now building

About the only figures of this kind that may have value are the drafts of the principal types of vessels now being built in large number by the U. S. Maritime Commission. The draft of these vessels ranges from 23 ft. 7½ in. to 29 ft. 13⅛ in., with the larger number being in the 27 ft. 7⅞ in. class, as shown in Table VIII. Since that table was prepared the number of C-2 cargo vessels has been increased by 60, three have been added to the C2-S1-A1 class and four to the C1-A class.

The fact that the large majority of the ships now being built by the Maritime Commission have drafts in excess of 27 ft. does not necessarily exclude those ships from the projected 27-ft. canal (25-ft. draft) because bulky cargoes such as automobiles do not load a vessel to its designed draft.

Nevertheless, the fact that the great majority of the ships now building have a draft in excess of 27 ft. seems to call for a reconsideration of the depth of the proposed waterway.

TABLE VIII—SHIPS UNDER CONTRACT AND UNDER CONSTRUCTION

U. S. Maritime Commission

Design	Draft	No. Ships
C1-A, Cargo	23 ft. 7½ in.	4
C2-S1-A1, Cargo, Alcoa	25 ft. 1½ in.	3
C-2 Cargo	25 ft. 10½ in.	26
C2-SU, Sun	26 ft. 7½ in.	8
C2-S-A1, Cargo, American Export	27 ft. 1½ in.	4
C-2 Seas Shipping Co	27 ft. 1½ in.	5
C-3 Passenger & Cargo	27 ft. 7½ in.	14
Passenger & Cargo, Miss. Ship. Co	27 ft. 7½ in.	3
C1-B, Cargo	27 ft. 7½ in.	23
C-3E, American Export Lines	27 ft. 9½ in.	1
C-3 Cargo	28 ft. 7½ in.	15
Tankers	29 ft. 13⅛ in.	11
Total		117
Projected Program		
Emergency Ships	27 ft. 7⅞ in.	312
Tankers	29 ft. 13¾ in.	72
Total		384

The matter of seasonal closing has been greatly overemphasized by opponents of the project. Montreal harbor is open on an average 230 days in the year, and when sailing time to and from Montreal and European ports is added the closed season is not important especially as grain, the chief commodity, can and does move overland to an all-year port at St. John, N. B., or to New York if market conditions in Europe make that a paying proposition.

Economic benefits

No question in connection with the waterway is more controversial than that of the economies that will result from its construction. In the early days of active promotion of the waterway, savings of from 8 to 10c. a bushel on grain were estimated; but by 1925 the Montreal-Liverpool rate had declined to around 10c. a bushel. At the same time the rate from Duluth to Montreal was about 9c., so that any such saving as 8 to 10c. was obviously out of the question. The Brookings report estimated the possible saving at about 4c. Wm. H. Coverdale, president of the Canada Steamship Lines, in a paper prepared for the Chamber of Commerce of the State of New York in 1932, claimed that tramp steamers going to the head of the lakes would lose from 0.29 to 0.04c. per bushel in attempting to compete with the boats built especially to handle grain on the lakes after crediting savings in elevator charges to the tramp steamer.

Rates to Liverpool just before war was declared were around 9c. per bushel on grain moving through the port of Montreal.

Out of the conflicting claims, this alone seems clear: No simple computation of savings in operating costs over one type of waterway as compared to another gives the answer because export grain rates are fixed by forces independent of operating costs. On this point W. T. Jackman, professor of transportation, University of Toronto, said recently: "If Canadian wheat could be laid down in Great Britain at lower cost as a result of the deepening of the St. Lawrence waterway, the British importer would not continue to pay the previously higher price. If Canadian wheat could be landed in Great Britain at lower cost and lower price, the other countries of supply (Argentina, Australia, India and Russia) would feel the effect of this competition and would find it necessary to take lower prices for their products. Again, if the world's wheat crop is larger in relation to demand—as has been evident in recent years—the importer knows that he can then get his wheat at a laid-down price which is in accordance with these conditions, and he will not offer more than he must pay to satisfy his requirements."

Despite this fact, it does appear true that the grain growers of the Middle West would have their competitive position in world markets improved by a waterway that cuts the cost of moving grain to Montreal. That the cost to the two nations at large of improving that competitive position is justified is not evident.

The Brookings report estimated that the taxpayer of the two countries would contribute about 11c. a bushel as the cost of building and maintaining the waterway in order to make possible the saving of 4c. As the Brookings estimate of traffic now is seen to be low in the light of actual movement through the canal in recent years, this figure doubtless is too high, but it still must be above any possible saving.

Effect of the war

What effect the European war will have on future traffic in the St. Lawrence is one of the many unknowns. That it will result in a curtailment of European purchases of American products in the post-war period seems highly probable, unless we loan money to European countries to permit such purchases. Also, between competition from South American

countries and Russia, it appears highly probable that the export of grain, which is by far the largest item in the canal traffic, will decline rather than increase in the post-war period.

That deepening the St. Lawrence canals may provide profitable inbound cargoes for boats seeking a load of grain is one of the reasons why the coal-producing states and the American railroads are so opposed to the seaway. This country now sells large quantities of coal to Canada. If British coal, which has the benefit of preferential tariff rates, or coal from northern Europe mined under the depressed conditions that will prevail there following the war can be laid down at Toronto or at Fort William without the cost of transshipment at Montreal, it seems highly probable that our coal trade with Canada would be materially reduced. Superficially this might appear to be beneficial to Canada, but as we are Canada's best customer its effect on the already unequal balance of trade might in the end be found to be unfavorable.

On the other hand, if deepening the waterway develops little new business and simply opens up the Great Lakes to foreign vessels which will bring down grain now carried in American or Canadian lake boats, American and Canadian labor organizations will not remain silent under that type of competition from foreign labor.

The adverse effect of the waterway on the railroads of the two countries is a factor that must be set over against possible benefits in any study of the project. Were tolls to be charged for use of the new canals and the deepened lake channels to offset the cost of construction and operation, less traffic would be diverted from the railroads, and the railroads would have little cause for complaint. But when the ships that take traffic away from the railroads—say automobiles from Detroit to ports of the Atlantic seaboard—are indirectly subsidized by the government, the nation has good reason to raise question as to whether the end result really is beneficial. This is more frankly recognized in Canada where the government owns the larger of the two railway systems serving the country.

The changing power scene

Waterpower plans did not figure prominently in discussions of the development of the St. Lawrence River until after 1900. Just about that time the Aluminum Company of America completed its power development at Massena, a project that diverts water from the St. Lawrence above the Long Sault Rapids and carries it through a canal across to the Grass River valley where 90,000 hp. is generated in the drop into the Grass River. In 1907 the Long Sault Development Co., a subsidiary of the Aluminum Co., was incorporated in New York State and given the right to build a dam across the St. Lawrence in conjunction with its Canadian subsidiary, the St. Lawrence Power Co. In 1916, before work was started but after much land had been acquired, the state court of appeals declared that act void.

The World War stimulated the use of aluminum, and following the war, in June, 1920, Hugh L. Cooper & Co., presumably representing the Aluminum Company of America, filed application with the recently created Federal Power Commission for authority to build a dam in the St. Lawrence River above Croil Island for the development of 1,000,000 hp., one-half in Canada and one-half in the United States. New York State opposed the application before the

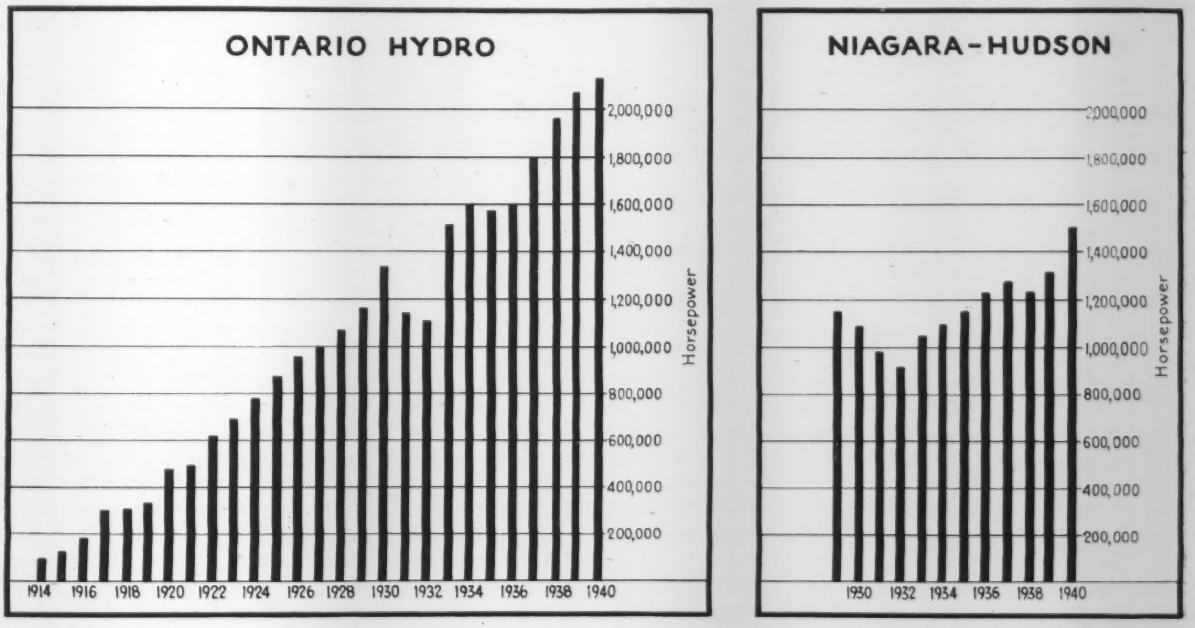


Fig. 7. Growth of load on the systems of the Hydro-Electric Power Commission of Ontario and the Niagara-Hudson Power Corp., the systems serving the industrial areas to the North and south of Lake Ontario and the international section of the St. Lawrence River. The chart shows December peaks for the Ontario Hydro and system peaks (60 min.) for Niagara-Hudson. The St. Lawrence plants would not be close to the load centers of either system.

Federal Power Commission because its rights were not adequately protected, and in 1921 created the New York Water Power Commission, empowering it to issue 50-year licenses for private development of state-owned power sites. In the same year the Frontier Corp. was created jointly by the Aluminum Co., Dupont and General Electric. Five years later Colonel Cooper, as representative of the Frontier Corp., submitted to the New York State Water Power Commission a plan for the complete development of the international section of the river for both power and navigation which called for the development of 2,400,000 hp. at a cost for the power of $237,152,000.

New York claims the power

These efforts to start development of the St. Lawrence with private capital directed attention to the unanswered question of whether power rights in the international section of the St. Lawrence belong to the federal government or to New York State. To protect its rights, New York passed an act in 1931 which declared those parts of the river lying within the state to be a natural resource of the state and created the Power Authority of the State of New York to develop the hydro-electric power and to cooperate with the United States Government in the development of navigation. That act put an end to all plans for private development of the power on the New York side. On the Canadian side, the same question was settled years ago by the creation of the Hydro-Electric Power Commission of Ontario.

Though no progress was made in developing the power along the Ontario-New York border other than the early development at Massena, steady progress was made farther downstream where the river lies wholly in Quebec. The first developments were at Cedars Rapids in the Soulanges section where water is diverted into side canals through which it is carried to powerhouses below the rapids, the largest development being that of the Cedars Rapids Manufacturing Power Co. A total of 226,000 hp. is developed in that manner. In 1929 the first work on an overall development of the 82-ft. drop from Lake St. Francis to Lake St. Louis was begun. That plant has a potential capacity of 2,000,000 hp. and has an installed capacity of 583,000 hp. The agreement under which private interests were permitted to undertake this Beauharnois project provides that the intake canal can be used as a navigation canal when required, the government building locks near the powerhouse.

The need for power

The St. Lawrence power question is shrouded in almost as thick a haze of controversial claims as is the waterway, but definite conclusions concerning at least some elements of it are much less difficult to reach. In the first place, most of the controversy finds its origin in the old question of private versus public power development, although spokesmen for and against the project try to make it appear that the issue is more fundamental. Proponents of the waterway and power scheme would make it appear that the St. Lawrence power is badly needed and that the electric utility companies have let New York State fall behind the rest of the country in the development of its water power resources. Opponents claim that the power is not needed, that it is remote from industrial centers of the state, and that the state's power needs can better be met by steam stations near the centers of demand. The truth lies in between. New York now lags behind the rest of the country in development of its water power resources only because it surged far ahead of the rest of the country years ago and now has few water power resources left that can be developed economically other than those in the St. Lawrence. Development of those resources would have been undertaken 20 or more years ago had it not been for the international complications and had not a sentiment against private development of those vast resources begun to build up in the state before private development got underway.

That the state does not now have as large a margin of power resources as it should have doubtless is true, but responsibility for such a condition cannot be placed entirely upon the utility companies. Responsibility for that situation in New York as elsewhere in much of the country lies in large measure with the federal government for its failure to set up a definite policy with regard to public power development that would permit the electric utilities to lay down long-range plans of power plant construction without fear of having to meet an unknown amount of competition from public financed projects.

On this point the statement of Thomas H. Hogg, chairman and chief engineer of the Hydro-Electric Power Commission of Ontario, made about a year ago when discussion of the St. Lawrence development was revived, is significant. He said, "What we must know, and must know soon, is whether or not the St. Lawrence is to go ahead at once. Our plans for the next five or six years will be very different in the one case from the other." What was true in Ontario, where there is no question of private versus public power development, was equally true on this side of the border; uncertainty as to what the federal government was going to do in the way of power development kept others from completing their plans and produced a wholly artificial power shortage that now has been made doubly serious by the demands of the defense program, which no one could possibly have foreseen.

Power can be used

Opponents of the scheme also distort the facts when they claim that the St. Lawrence power is not needed and is too far from industrial centers to be useful. They are answered most effectively by a quotation from Hugh L. Cooper's statement to the International Joint Commission in 1920: "Our reply is that there is an existing market justifying the immediate development of the Croil Island site, and that if the future can be judged by the past history of the hydro-electric industry, market demands for cheap reliable hydro-electric power will always outrun the supply." Cooper proposed an initial development of 400,000 hp. Then as now, step by step development of the power was proposed as the market developed. Just because the tables are turned and the state now proposed to develop the same resources does not alter the fact that the St. Lawrence power can be fitted into a logical plan for meeting the state's growing needs without injury to the existing suppliers of power, provided the New York State Power Authority adheres to its policy, as stated in its annual report of last year that "the Power Authority plan assumes that distribution of power will remain, as today, largely in the hands of the private power systems, provided they cooperate in the public

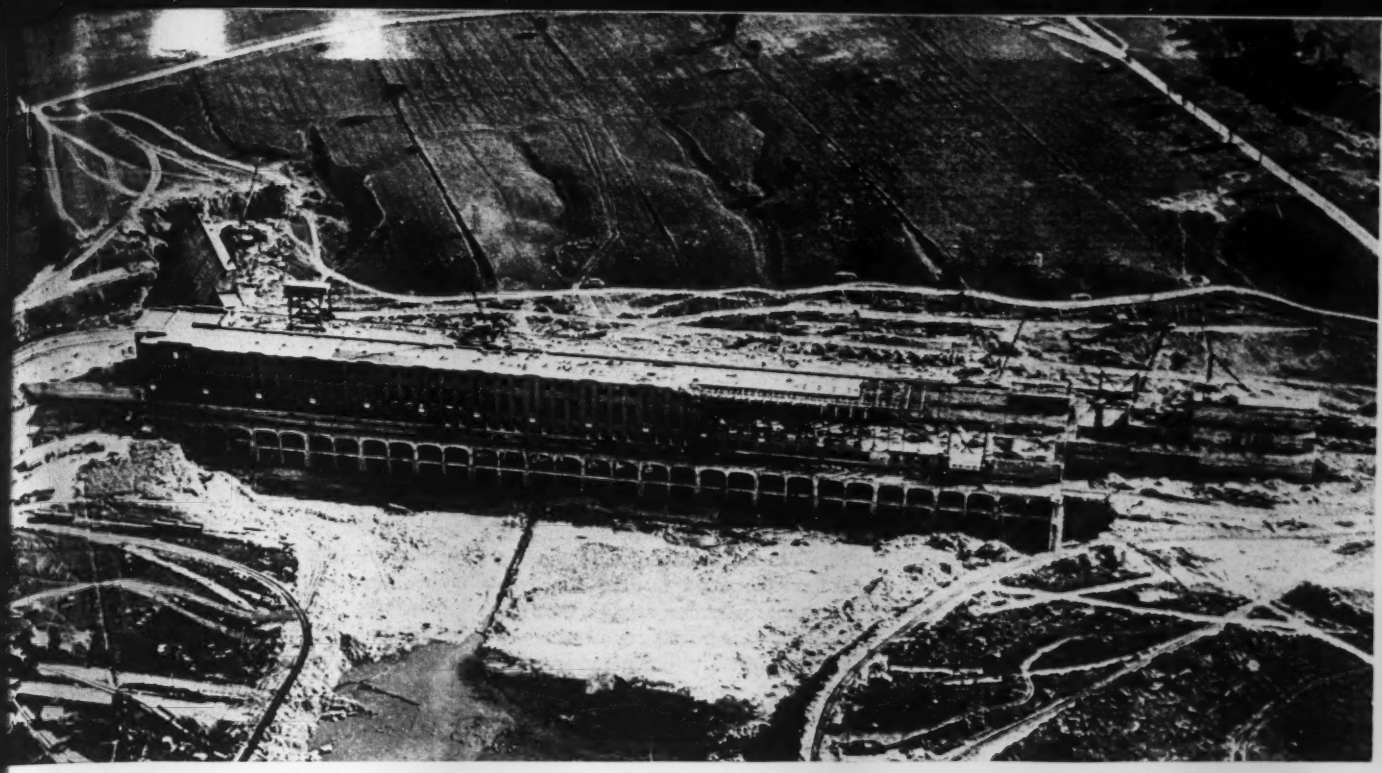


Fig. 8. A forerunner of what is now planned for the International Rapids section of the St. Lawrence River is the great Beauharnois powerplant, here shown under construction in 1931. It develops the full 83-ft. head between Lake St. Francis and Lake St. Louis. Eleven 53,000 hp. units have now been installed and two more are being added. Ultimately 2,000,000 hp. can be developed at this site. The land behind the powerhouse now is submerged in a canal that can be used for navigation by dredging a deep channel at one side.

purpose of selling electricity in abundance at lowest possible rate."

Recent developments in the transmission of electric power have greatly expanded the area to which the St. Lawrence power can be transmitted economically. Power from Boulder Dam is now being transmitted 287 miles to Los Angeles, which is about the distance from the Barnhart Island plant on the St. Lawrence to New York City. However, transmission costs probably would not make it practical for St. Lawrence power to complete with steam power at New York.

Cost of power

Cost figures for St. Lawrence power as compared with steam power cannot be given with any assurance of accuracy because so many uncertain factors are involved, thus making it possible to arrive at a wide range of results depending on what basic assumptions are made concerning these factors. Estimates given in *Government Hydro vs. Private Steam Power,* prepared by the New York Power Authority, put the average cost of St. Lawrence power delivered at substations 50, 100 and 200 miles from the main powerplant, when that plant is operated at on an 80-percent load factor *to carry the base load of a system having other plants to carry the peak loads,* at 2.6 mills per kilowatt-hour as compared to 5.0 mills for power from a modern steam station delivered at the same substations. The Niagara Frontier Planning Board, which is opposed to the project, estimates that St. Lawrence power delivered to substations at Syracuse (140 miles) and Rochester (200 miles) will cost 2.86 and 3.16 mills, respectively on the same load factor as against 4.0 mills for steam power. As to estimates of St. Lawrence costs, all estimates are materially affected by the rate at which the power can be absorbed due to the high initial investment in dams and control works, intake structures and substructures for the power plants, all of which must be built at the start.

Growth of power load

Some idea of the rate of growth of the power load on each side of the border can be obtained from Fig. 6, but the indicated growth for the New York side is less than what could safely be estimated for a power plant on the St. Lawrence because such a plant could reach out beyond the area served by Niagara-Hudson. Also, in the light of what has taken place in the Tennessee Valley and around Bonneville, it is reasonable to conclude that cheap power along the St. Lawrence will attract new industries needing large quantities of power. It should be noted, however, that the St. Lawrence powerplants will not be as conveniently located to serve existing load centers as are the Niagara plants.

Power at Niagara

No discussion of power development under the proposed agreement with Canada would be complete without reference to the power situation at Niagara because one of the apparent deficiencies of the agreement signed in March is its failure to rectify the present inequitable distribution of water for power development in the Niagara River. Equalization of the present diversions plus half the 10,000-cfs. increase that is proposed under the agreement would add 13,000 cfs., to the power available in New York, which when used in an over-all development of the 312.5-ft. head between the river above Niagara Falls and Lake Ontario, as is done in the Queenston-Chippawa plant in Ontario, would produce 370,000 hp. If

the total diversions can be increased by twice the 10,000 cfs. provided for in the agreement after completion of remedial works above the falls, which appears probable, the total new power on the New York side at Niagara can be increased to more than 500,000 hp., or nearly half what New York will get in the St. Lawrence development. This power might cost somewhat more than the St. Lawrence power but it would be nearer the load centers and probably could be put on the line in much less time than would be required to dam the St. Lawrence. If more power is needed badly, more efficient use of the Niagara resources appears to be the answer.

Conclusions

Nothing has been said so far as to the claim that both the power and navigation facilities are needed as defense measures. From the limited perspective of today that appears to be a specious argument. Four years at best will be required to build such works in a river of the magnitude of the St. Lawrence, and five years—Col. Cooper's figure—seems more probable. The shipbuilding program will reach its peak early in 1943, two years from now, according to statistics compiled by the Department of Labor, and four years from now will be substantially complete.

Canada does not look on the St. Lawrence development as a war measure and does not want to divert the necessary money from what the government considers more essential work. That is clear in the exchange of correspondence which preceded signing of the waterway agreement. The government only approved the agreement after President Roosevelt sent a personal note to Prime Minister King setting forth in detail why he believed that both the power and the seaway were needed for defense. Countering the Canadian claim that at best the project could not be completed for four years and so would be no help in the current intensive defense effort, President Roosevelt said: "We are today appropriating money for construction of vessels of war which will not be ready for service until completion of the St. Lawrence undertaking." Some of these war vessels, he added, could be built in Great Lakes shipyards, thus freeing coast shipyards for construction of cargo vessels which can be built in much less time to meet urgent shipping needs. The waterway, President Roosevelt said, would be completed in time to provide an outlet to the sea for the war vessels.

The only vessels in the present shipbuilding program that might not be completed until the earliest possible date at which the seaway can be completed are cruisers and battleships. It seems incredible that the Navy would agree to build warships in the Great Lakes on the assumption that a canal to let them down to the sea will be completed by the time the ships are ready for service. Cargo vessels are the most urgent need of the moment. The Great Lakes shipyards could be used to build cargo ships that could go out light through the present canals.

Economic considerations

Turning from defense to economic considerations, little can be found to justify spending millions on building the seaway. The present canals can carry all the traffic that is available and much more traffic can be carried through the New York state canals before they are up to capacity. Without doubt some ocean-borne freight that now has to be transshipped at Montreal, New York or Albany would go up into the Great Lakes in ocean vessels but the amount appears insignificant in relation to the cost.

No time since the turn of the century appears less propitious for the start of the seaway. Until we know more about post-war foreign commerce and post-war ocean shipping no money should be spent on the project. If dams are built across the St. Lawrence for power they should include such elements of the locks as are necessary to permit construction of the seaway at some later date, but further work should await further knowledge of future trends in world commerce.

If the peak of our defense effort is to come in 1943, this is not the time to start construction of a big power project that will begin to produce power two years after the artificial peak demand of the defense effort is past. A more logical program, assuming that public construction must be stepped up in the post-defense period, would be to complete the plans and specifications for the project, set a tentative date for the start of work at, say, January, 1943, so that it will be getting under way as the defense effort falls off.

New treaty needed

The agreement that forms the basis of the navigation and power developments discussed in the foregoing is a makeshift, a pill that has been sugar-coated for the Canadians by sacrifice of essential rights of the United States. It should not be approved in its present form.

A new treaty to replace the boundary water's treaty of 1909 is urgently needed. It should provide for immediate construction of weirs to redistribute the flow over Niagara Falls and for a comprehensive study of regulation of the flow at that point to permit more efficient use of the flow of the Niagara River. Canada's rights to the waters now being diverted into Lake Superior should be recognized and diversions from Lake Erie or the Niagara River for the Welland Canal and the New York Barge Canal as well as from Lake Michigan for the Illinois waterways should be frankly recognized and made subject to control by an international board. Movements of power across the border, and possibly oil by pipe line, similarly, should be placed under control of a joint commission. Finally, the groundwork should be laid for work on the St. Lawrence power and navigation project by a separate agreement at such time as the two governments may determine without the necessity of opening up all other subjects covered by the treaty. The engineering work now being carried on by the international engineering board and by the district engineer at Massena should be carried forward actively so that the work can be inaugurated as the defense effort declines if that is found desirable; and the engineering work should include a restudy of the waterway to determine whether, in the light of our present ship-building program, provision should be made for deeper locks or whether the whole navigation project should be converted into a barge canal. All new costs should be carefully determined and clearly set forth along with a detailed study of expenditures already made on the seaway to the end that each country can get proper credit for work already done and each can be assigned an equitable share of the cost of future work.

Placing and Welding Reinforcing Steel In Pit River Bridge Piers

***Contents in Brief**—Electrically welded butt-joints connect bars 2 in. square and 60 ft. long, spaced a minimum of 6 in. apart both ways. Interior steel scaffolding for supporting the bars temporarily; gas burners for preheating; clamps for holding bars at exact spacing until welded; 8,280 welds on 2-in. bars required to complete the job.*

AN UNUSUAL ASSEMBLY of reinforcing steel has just been completed in the Pit River Bridge piers, whose height ranges up to 363 ft. The bridge is part of the railroad relocation necessary to getting the Southern Pacific's main line out of Shasta Reservoir. Factors that affected pier design, including earthquake, impact, earth compaction and movement of surrounding water, are described in *Engineering News-Record* May 8, 1941, p. 736. Methods of construction are described in the following:

The problem of placing and supporting in exact position the long pieces of heavy reinforcing steel was solved by erecting within the pier area a central tower of scaffolding whose vertical members are second-hand 60-lb. T-rails. This framework, aligned by transit, served as guide and support for the reinforcing and also for the internal concrete forms which shaped the cells (for saving concrete) in the two larger piers. Vertical members of the scaffolding were arranged in three rows or bents each consisting of five vertical rails. Diagonal bracing, varying with the height, included some steel angles and some timber members.

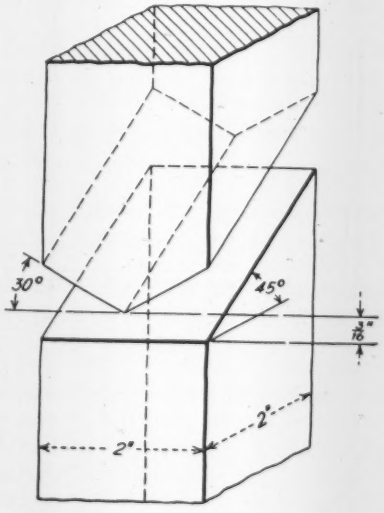
Cross-members were 6x6's resting on and bolted to 2x2x6-in. angle-iron clips welded to the T-rails that served as columns or posts. Diagonals were mostly 2x6's, U-bolted to the T-rails with ⅜-in. bolts. Supplemental sway bracing of 2x2x¼-in. angle iron was used where required by height of scaffolding above concrete.

The timber was removed ahead of the concreting but most of the steel falsework, including the rails, was embedded in the concrete. At vertical intervals of about 12 ft., a 6x6-in. timber frame was built horizontally around the scaffolding to support the working floors. These floors were used in working on the steel bars, placing internal forms and delivering concrete to the elephant trunks.

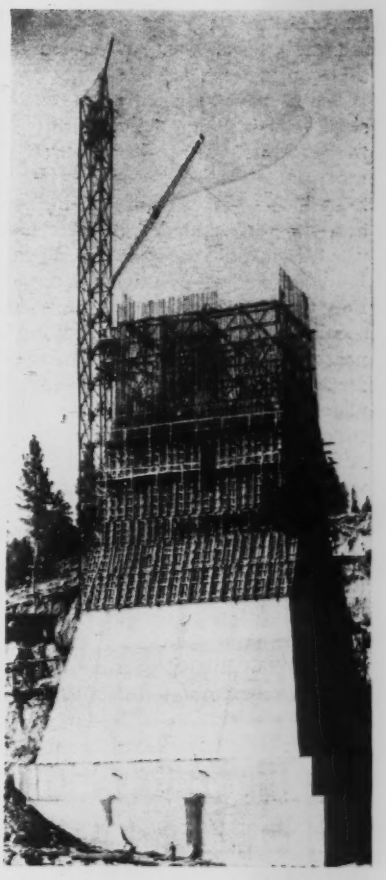
The wood boxes forming the hollow core spaces were built up in place as the central supporting structure was erected. Timber in these core forms was all removed through a 30-in. circular opening at the top of each form. These internal spaces, for stability reasons, are connected with the reservoir by 4-in. galvanized pipes and water level inside is to correspond with that in the reservoir.

Two methods for delivering materials were provided. A derrick boom mounted on the elevator tower and raised as the work advanced, hoisted and placed all materials except concrete. Concrete went up in a skip in a structural steel frame carried up alongside the pier as the work advanced. Concrete was brought to each pier in dry batches by dump trucks which discharged directly into the mixer at the base of the elevator. At the successive pour levels, where concrete was discharged from the elevator, side-dump cars or hand buggies were used to deliver to hoppers of elephant trunks. Ordinarily the concrete was carried up about 30 ft. before raising equipment to the next working level.

In lower portions of the two largest piers, because of the quantity of concrete in solid masses, cooling



Sketch of bar ends as shaped for welding.



Construction of a bridge pier with reinforcing supported by interior framework. Derrick boom for placing materials is mounted on concrete skip tower. Note workmen at base of pier.

water was circulated during the curing period, in a system of pipes spaced in layers 5 ft. apart vertically, similar to the method used in large dams. Only the lower 35 and 40 ft., respectively, at the bottom of the piers required this treatment. In these sections concrete pours were made 5 ft. deep, permitting each layer of pipe to be assembled on top of a pour. The temperature of water pumped up from Pit River was low enough for this cooling operation.

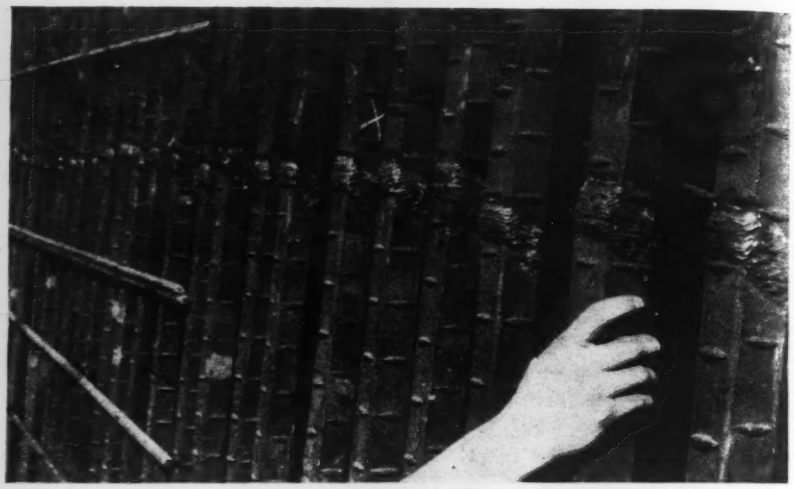
Wood panels, usually in 8x12-ft. sizes, constituted outside forms for the concrete. They were held 6 in. away from the outer vertical row of 2-in. bars by means of 5x8-in. rods and she-bolts fastened to ¾-in. hairpins which were previously imbedded in concrete at required intervals. For the four corners of each pier special form panels were used, cut to neat lines and fitted with 2-in. chamfer strips. The edges of all form panels were brought to a true edge to conform to the specified batter. After forms were stripped joint beads were smoothed off with motor-driven abrasive discs using number 60 grit.

Where clearances were relatively small around core forms or reinforcing, maximum aggregate size was limited to 3 in. although 6-in. cobbles were used in the base and in the more open upper portions of the piers. Vibrators were used under careful supervision to insure getting concrete properly placed around the steel.

The 2-in. steel bars came to the job in lengths ranging up to 60 ft. These longest bars weighed about 813 lb. each (13½ lb. per linear foot). All 2-in. bars were picked up by the derrick one at a time and lifted in a vertical position. The boom was set high enough so that the bars could be threaded down vertically in their respective places in the four successive rows. As each bar was landed on the end (top) of the preceding bar, the prescribed spacing was secured by placing a small piece of $\frac{3}{16}$-in. metal plate on top of the bar below and lowering the next bar into place upon it.

When the new bar was thus rested with the proper spacing above its predecessor, the two ends were fastened firmly together by a clamp extending about 10 in. below the top of the preceding bar and 10 in. above the bottom of the newly placed bar. Four pairs of ears on these clamps had slots into which wedges could be driven, two on the old and two on the new bar, to constitute a purchase for rigidly holding the clamp until the welding could be done.

As soon as the clamp wedges fastened the bottom of the bar, it was also fastened at other points along its length by number 9 wire ties passing around 2x3-in. templates. These templates, spotted to exact position by transit, were supported on the 6x6-in. cross-members at vertical intervals of about 10 ft. They extended entirely around the outline of the pier and were left in place until, as the concrete level approached, they were no longer needed as guides or supports.



Completed welds in 2-in. bars. Welder puts his mark on each joint; tests at intervals of about 100 welds are required to show 80 percent of bar strength.

Welding butt-joints of 2-in. bars. Note clamps at left holding bar ends. At extreme left is gas burner preheating the bars.

Joints staggered

The different bar lengths were used to break joints as desired. Welds in any one row of bars were usually at the same height for convenience in welding, but the joint levels in adjacent rows were made to differ by at least 5 ft. There are some exceptions in pier four where welds in two adjacent rows went in at the same level.

The two ends of bars to be electrically welded were cut at 45-deg. angles and, in addition, the upper bar had the metal cut away to an angle of 30 deg. with the beveled face of the bar below. This afforded just the spacing required for the

amount of weld metal desired in each joint, which ranged from 1½ to 1¾ lb. Welding was done in 9 to 12 passes around each joint.

The metal spacer plate was removed before the welding began. After the first two beads had been put on, the clamp was no longer needed and was removed to give the welder access to all four sides of the joint. Molten metal put into the weld in the first two passes did not stick to the clamp because of a copper facing plate on the clamp in the zone of the weld. (Weld metal does not adhere to copper.) Each bead was peaned except the last.

Bars preheated

Prior to starting each weld, the adjacent bar ends were heated by gas burners that raised the temperature in 8 or 9 in. of each bar adjoining the weld to about 500 deg. F. This was done with a 2-flame natural gas burner, one flame on each of the bar ends. This heating operation, for which the burners were set by a welder's helper, required about 8 to 10 min. on each weld.

Propane was used as a preheating fuel during winter months because with it there was less tendency for valves to freeze than with other fuels. It was delivered to the job in tank-trucks in liquid form and discharged into 28-gal. barrels. With four burners operating from a barrel, pressures of 12 to 15 lb. per square inch were maintained. For other than the cold weather months, butane gas was found to be a more economical fuel because of its faster heating qualities.

Ordinarily the welders worked in pairs (or in several pairs) to facilitate supplies and incidental operations. As welding progressed in each joint each successive bead was cleaned off by means of a pneumatic peaning tool kept (by the helper) ready for service within convenient reach of each pair of welders. The cutting edge of the peaning tool was purposely kept dull so that it would not cut into the weld metal but would effectively remove scale.

Overall completion of each weld usually required slightly less than an hour; with incidental work, a weekly average was about 8 welds per man per shift. A welding shift ordinarily included four to six welders and a helper. Piers 3 and 4 required 2,926 and 3,896 welds, respectively, in the 2-in. reinforcing bars. The total number of these welds in all piers was 8,280.

In addition to passing the welding tests required before welders were qualified on this job, the work of each man was checked at intervals of about 100 welds (about every 12 days) by cutting out one of his welds with a hacksaw and making a full scale test upon it in the large tension machine at the University of California. In these tests, tensile strength of the welds was required to be 80 percent of the strength of the bar itself. To make sure of identities, as each weld was finished, the bar just above it was branded in metal by the welder using an initial as assigned to each man by the foreman.

The work is being done for the U. S. Bureau of Reclamation; R. S. Calland, Sacramento, is acting supervising engineer for the Central Valley Project; Ralph Lowry, construction engineer, Kennett Division. Contract for construction of piers is held by the Union Paving Co., San Francisco, H. L. Morisette, general superintendent. Welding was sublet to the J-K Welding Co., Long Island City, N. Y.

The plans and designs for the Pit River bridge were prepared in the Denver office of the Bureau of Reclamation under the direction of the bureau's bridge engineer, Robert Sailer, working under the supervision of H. R. McBirney, senior engineer in charge of the canals division. The executive and engineering work of the Bureau is under the direction of S. O. Harper, chief engineer.

Twenty-Six-Mile Cable Tramway Carries Crushed Stone

A ROPEWAY or cable tramway 26 miles long has been built to carry limestone from a crusher plant at the quarry to a cement mill at Koping, Sweden. Railway, canal and motor-truck transportation were all considered, but were abandoned as less convenient and economical than the ropeway. According to a description in "The Engineer," of London, England, this exceptionally long cable tramway will have a normal capacity of 90 tons per hr. or 475,000 tons annually. With additional buckets and longer working hours, this annual capacity might be increased to 750,000 tons. The location is over comparatively level country.

There are four divisions of practically equal length, each with its separate hauling cable and 135-hp motor, driving through a V-belt and gearing to the periphery of a double-grooved pulley 12 ft. in diameter. These pulleys are fitted with appliances for equalizing the wear in the two grooves. Of the three driving stations, the one at the middle has two motors, for two divisions of the line, while each of the terminal stations has one motor. There are also two intermediate stations and twelve tension stations for the track cables. The two track cables are spaced 11½ ft. c. to c., with the endless hauling cable directly below.

Each bucket is of cylindrical shape, with capacity for 2,640 lb. of stone. Its bail is attached low down and is latched to the top, thus insuring rapid and complete overturning of the bucket when unlatched at the discharge station. The head of the bail is attached to a trolley having two pair of grooved wheels in tandem, and riding on the track rope. The normal speed is 8¼ ft. per second. In operation, the buckets are spaced about 400 ft. apart, or at intervals of 48 seconds, by means of a starting device at the loading station. This station has also power-operated loading chutes for filling the buckets.

Instead of the usual bents or towers to support the cables, each support consists of a single concrete post or column with a T-head or cap. For crossing the Hjalmaren Sound, the longest span will be 1,770 ft., carried by supports 158 ft. high in order to give a clearance of 85 ft. below the buckets in the sag over the navigation channel. Elsewhere in this crossing the minimum clearance will be 20 ft. For 85-ft. clearance of a 500-ft. span crossing the Arboga River, the supports will be 108 ft. high. Of the 216 supports, 210 are the single posts mentioned above. The others are of "special" design, but whether they are bents or towers is not explained in the original article.

From Field and Office

Working problems and time-saving methods for engineers and contractors

Easy Method of Balancing Grading Yardages

Yardage in highway grading can be balanced with relative ease by the method of grade change illustrated and described here. This method has been used for four years by the Tennessee highway department and has been found particularly valuable now that practice requires straight grades and long vertical curves for sight distances of at least 1,000 ft. Contrasted with the old rolling grade the new practice calls for a different technique in balancing to keep overhaul of excavation at a minimum and provide for the best possible haul from cuts to fills.

Referring to the illustration: After the grades have been laid and the yardage on the entire project has been figured, control balance points should be spotted wherever possible, as for example, at the beginning and the end of the project, at the ends of some bridges and at other points where balance points are especially desirable. These control balance points should not be farther than two or three grade lengths apart; that is, the designer should figure on changing about every third grade.

Now that the control balance points have divided the yardage into sections, balancing is only a matter of detail. A summary of yardage should be made, taking into account all extras, such as channel change, ramps and fill deductions for curves, to determine exactly how much the section is out of balance. In the example illustrated the section was found to be short 2,875 cu.yd. of excavation, and the grade must be lowered for that amount. The procedure is then:

1. Ascertain the average template width over the effective changing distance. The grade change will be effective from one-half the distance from the first P. C. to the P. I. to one-half the distance from the second P. I. to the P. T.; in the example this is from station 83 + 50 to station 94 + 50. The template width (distance from slope stake to slope stake) is scaled from the cross-sections every 50 ft. These template widths are added and divided by the number of entries to determine the average template width. In getting the average template width, only every 50-ft. cross-section should be taken since odd plusses will distort the true average.

2. The amount of grade change should be figured using the formula:

$$\frac{Y}{\frac{W L}{27}} = X$$

when

Y = cubic yards of grade change
W = average template width
L = distance from P. I. to P. I.
X = amount of grade change

In the example, X was found to be 1.45 ft.

3. The new P. I.s are established to parallel the grade down the required amount, which is X in the formula and in the example is 1.45 ft.

In almost every instance the grade should parallel up or down. If on the grade change the grade can be steepened up, let's say, to eliminate more fill, the grade should have been laid that way at first. The grades should be laid to fit the ground as nearly as possible to give the required sight distance in the beginning, and not afterward when balancing. In the few instances where the grade is pivoted, the method described is not recommended.

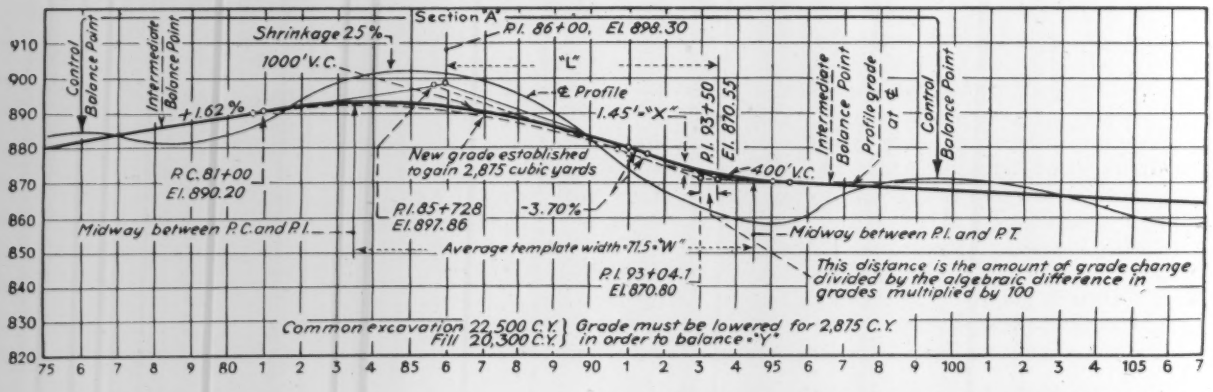
The new P. I.s should be established to the nearest tenth of a foot. This will prevent any change in the percent of grade or length of curve, and the difference in template elevation on the cross-sections will be the exact amount desired. Use the formula:

$$\frac{X}{\text{algebraic difference in grades}} 100 = \text{distance to new P. I.}$$

In making the grade change on the cross-sections, all backslopes should be paralleled.

After the change has been completed and the new yardage figured, an additional summary of the yardage should be made to determine the exact amount of shrinkage. The shrinkage factor should be within 2 percent of what was desired for that section. The intermediate balance points are then established to complete the balancing.—BILL TURNER, *Senior Designer, Tennessee Highway Department, Nashville, Tenn.*

Method of changing highway grades to balance yardages.

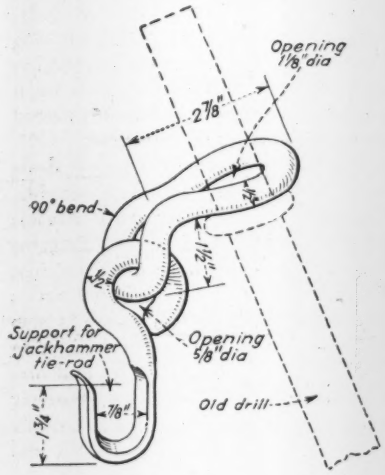


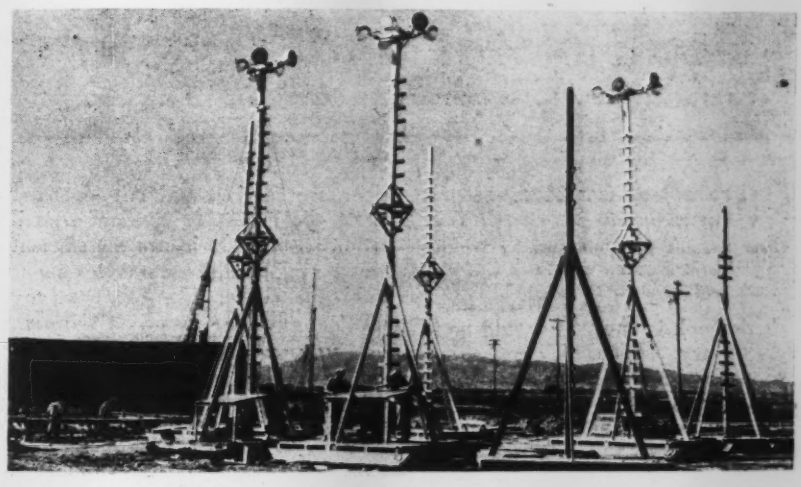
A Handy Drill Support

A handy means for supporting a jackhammer used in drilling horizontal holes is shown in the accompanying sketch. The device can be made easily in any blacksmith's shop and, with an old piece of drill steel 3 to 5 ft. long makes a combination that speeds progress because it makes the handling of the drill much easier.

The device consists of a chain link

A handy support for a jackhammer when drilling horizontal holes.





A group of portable lighting standards at Sepulveda Dam. Note the "desk" on two at left.

made into the shape of a somewhat distorted figure eight to which is attached a hook, left free to swing. The larger loop in the figure eight is passed over the top of the old drill steel and the hook serves as a rest for one of the tierods of the drill. If the type of drill used has no exposed tie-rod, a clamp and wing-nut can be substituted for the hook.

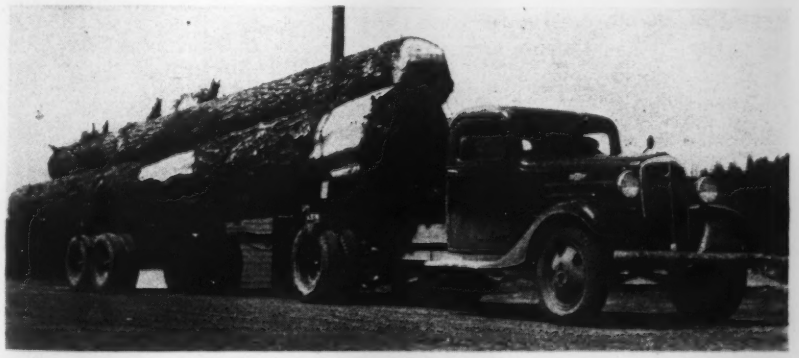
Motor Truck Logging

Logging by motor truck has increased in Oregon by leaps and bounds in the last year or two. More than one third of the total tonnage carried by Oregon roads consists of timber products. There are some state highway routes on which heavily loaded logging trailers move on average headways of 1½ min. throughout the daylight hours. Under conditions now obtaining in many parts of the state, logs can be hauled by truck cheaper than by rail, and hence a large part of the log movement has swung from railroad to highway.

A very real danger lies in the tendency of loggers to exceed the load limits prescribed to safeguard pavements. The one most frequently exceeded is the legal limit of 18,000-lb. per axle. In loading trailer trucks with logs such as those in the accompanying picture, operators require frequent checking to prevent overloading.

The state has supplemented the system of punishing offenders of this type by fines, finding that the only sure means of control has been to suspend the log hauler's license for 5, 10 or 15 days and, for repeated offenses, to cancel the license.

Oregon roads have been constructed with heavy foundations to carry such loads and as a result, state highway officials say, they should be able to carry heavy military transport, should the need arise.



Loads like this are daily moving over some of Oregon's highways on headways of 1½ minutes.

Portable Light Standards

Portable standards made of timber and guyed with wire stays are used to support five floodlighting units at high level where they effectively illuminate filling operations on Sepulveda Dam in southern California. Each unit is mounted on a 3-runner sled so that it can be hauled conveniently over the fill.

The central mast is usually 28 ft. high, is held upright on the sled by 4 timber braces joined by bolts just below the mast's midpoint, where horizontal struts are placed to hold out the four wire stays. These stays, one on each side, run from the top of the mast over the struts and back to the mast at its base. In addition to these supports, another set of 4 wires from the top of the mast to the four corners of the sled complete a bracing system that makes the unit rigid enough to withstand frequent movings.

To make the top accessible for replacing bulbs and other adjustments, cleats are bolted to the mast. Since the platform on the sled at the base constitutes a convenient place, day and night, for examining blueprints and making records, several of the units have been provided with a slightly inclined table, resembling a drafting board. This "desk" is used frequently by foremen and inspectors.

Sepulveda Dam, a rolled earthfill 90 ft. high, is being built by the U. S. Engineer Department. Contract is being carried out by Jahn & Bressi-Bevanda Constructors, Inc., J. A. Dowling and David G. Gordon on a bid of $3,121,267.

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

Protection for Civilians

CIVIL AIR DEFENSE—By Lt. Col. A. M. Prentiss, 334 pp. Published by Whittlesey House, McGraw-Hill Book Co., New York and London. Price $2.75.

This book is one that should be in the library of every organization which is doing any thinking and planning associated with a civil defense program in the United States. It brings out clearly in a very interesting way the variety of problems associated with the protection of civilian populations and with the functioning of normal civilian activities under war-time conditions. It is not a technical exposition, but rather a statement of information couched in language that anyone can understand. Much of the material, of course, is taken from British publications, but this does not detract at all from the value of the book, even though engineers recognize that our practices in this country differ somewhat from British practice in various technical fields. The British have developed an extensive literature dealing with every phase of civil defense and civilian protection, but it is a difficult matter to obtain and circulate in this country the large number of pamphlets and handbooks dealing with the various problems. Colonel Prentiss is to be congratulated for bringing together in one volume, which is published in this country and hence easily obtainable, so much of the diverse information which the British authorities compiled and published in a large number of documents just prior to the outbreak of the war and also during the initial months of the conflict.

It must be kept in mind that very little scientific literature on these matters has come from England since the intensive bombing began last fall, and, hence, it is quite possible that many of the recommendations which they made initially may be subject to change in view of their later experiences.

One of the chief assets of this book lies in the emphasis placed upon aircraft warning service, air-raid warden service, first-aid service, fire precaution service, rescue and debris clearance service, and last—but not least—the necessary civilian organization required to insure the efficient functioning of all these services under war time conditions.—*Reviewed by* HAROLD E. WESSMAN, *Chairman, Dept. of Civil Engineering, New York University.*

PROTECTIVE CONSTRUCTION—Structure Series, Bulletin No. 1. Prepared by the War Department. For sale by Supt. of Documents, Washington, D. C. Price 25c.

Designed to present the general background necessary for intelligent consideration of the subject of protection of civilians against air attack this booklet provides a useful outline of methods, plans and general procedures of interest to civilian engineers. The material is based on a study of the latest information from European sources, and it is intended as a general summary. Detailed data, now being assembled, will be available in booklets to follow.

FIRE DEFENSE—Prepared by National Fire Protection Association, 60 Batterymarch St., Boston, Mass. 221 pp. Price $1.50.

This is the first American publication covering all aspects of defense against war incendiarism and fire sabotage. It explains the problem of fire in wartime, dealing with such matters as air-set fires, bombs, sabotage, fire fighting, and the safeguarding of industrial production. The text includes a comprehensive report on British fire defense measures and among the contributors are an expert of the FBI, the director of fire services of the Civilian Defense Committee in the Canadian province of Ontario, and other technical experts in the fire field.

TVA Pollution Studies

STUDIES OF THE POLLUTION OF THE TENNESSEE RIVER SYSTEM—By G. R. Scott. Published by the Tennessee Valley Authority, Health and Safety Dept., Chattanooga, Tenn.

Stream pollution studies made by the TVA at the request of state health departments in the seven Tennessee Valley states are now available in published form. The report includes a general description of the Tennessee Valley with respect to geology, topography, and stream flow. It also gives the distribution of population by tributary watersheds, states, rural and urban, unsewered and sewered and having sewage treatment.

The major part of the report deals with conditions in the Knoxville, Chattanooga, Decatur and Muscle Shoals sections of the Tennessee River. The methods of sampling, analytical procedures and summaries of results are included. There is also a discussion of the rate of oxidation studies, time of flow studies, and precision of results. The author, sanitary engineer of the TVA health and safety department supervised the work and prepared the report.

New Engineering Books

CIVIL AIR DEFENSE—By Lt. Col. A. M. Prentiss. 334 pp. Published by Whittlesley House, McGraw-Hill Book Co., Inc., New York. Price $2.75.

RELAXATION METHODS IN ENGINEERING SCIENCE—By R. V. Southwell. 252 pp. Published by the Clarendon Press, Oxford, England. Price $5.

A PATHFINDER IN THE SOUTHWEST—The Itinerary of Lt. A. W. Whipple during His Explorations for a Railway Route from Fort Smith to Los Angeles in the Years 1853-1854. Edited by Grant Foreman. 298 pp. Published by The University of Oklahoma Press, Norman, Okla. Price $3.

THE BOULDER CANYON PROJECT—By Paul L. Klenisorge. 330 pp. Published by Stanford University Press, Stanford University, Calif. Price $3.50.

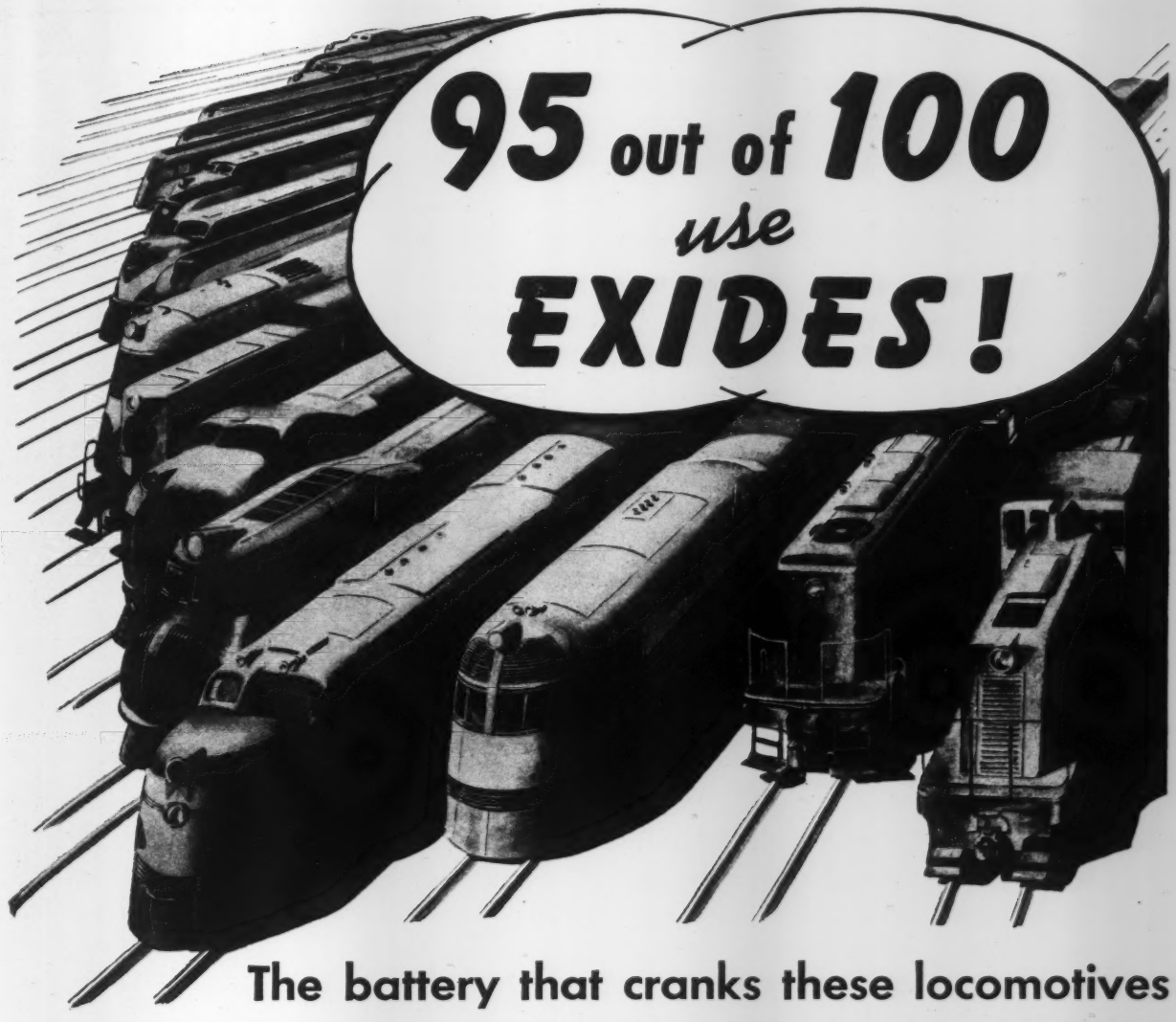
CONCRETE PRODUCTS AND CAST STONE—By H. L. Childe. 7th Edition. 263 pp. Published by Concrete Publications, Ltd., 14 Dartmouth St., London, S.W. 1, England. Price $1.90.

SOIL MECHANICS—By Dimitri P. Krynine. 451 pp. Published by McGraw-Hill Book Co., New York and London. Price $5.

INDUSTRIAL RESEARCH LABORATORIES OF THE UNITED STATES—7th Edition. Published by the National Research Council, 2101 Constitution Ave., Washington, D. C. Price $3.50.

THE MUNICIPAL YEAR BOOK 1941—Eighth Edition. 662 pp. Prepared by The International City Managers' Association, Chicago. Price $5.

(Continued on p. 90)



95 out of 100 use EXIDES!

The battery that cranks these locomotives can crank your Diesel engine *FAST*

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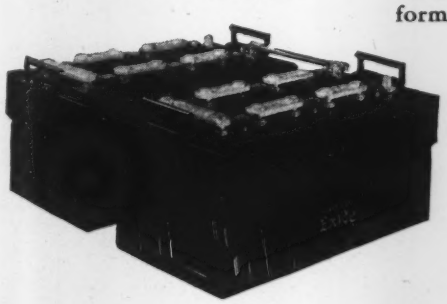


THERE are no more careful buyers than the railroads and the manufacturers of railroad equipment. Dependability is their first consideration. It is not by chance that 95% of all Diesel-powered locomotives have entered service equipped with Exide Batteries. The choice of Exides was based on their demonstrated ability to meet the needs of Diesel engine cranking with the utmost dependability and economy.

There are good reasons. From the start, Exide engineering regarded batteries for Diesel engine cranking as a matter for special research. The wisdom of this has been abundantly proved by the exceptional performance of Exides in Diesel engine service.

They have the tremendous reserve power required to crank a cold Diesel engine at low temperatures. They have the high voltage necessary to crank it fast. They have the ruggedness and long life needed to insure maximum dependability and economy.

There are Exides for every size and type of Diesel engine, from the smallest to the largest. Write us for full details.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

STATE STREET BRIDGE, CHICAGO, ILL.

OWNER: City of Chicago, O. E. Hewitt, commissioner of public works; W. W. DeBerard, city engineer; Stephen Machuda, engineer of bridges.

PROJECT: Construction of new double-leaf bascule bridge over Chicago River on North State St., including north approach viaduct over C. & N.W. Ry. freight yards. Work divided into three general contracts: (1) foundations of bridge and viaduct; (2) superstructure of bridge and viaduct, including bascule operating equipment; (3) electrical equipment, including all motors, lighting, warning gates and signals, wiring and submarine cables. Foundations are all Chicago Well caissons, carried to rock 110 ft. below river level. Superstructure of main span is double-leaf bascule, 245 ft. c.c. trunnions, each leaf 108 ft. wide, of three trusses carrying two 41-ft. divided roadways and 13-ft. walks. Viaduct is steel frame with concrete deck.

CONDITIONS: Old bridge has been removed and new double-track State St. subway has been built under the river. Cofferdams on both shores for subway construction were left in place with provision for extending up and downstream for constructing main bridge piers. Bridge caissons close to subway were put down by subway contractor. River is navigable and must not be obstructed. Double-deck Wacker Drive along south bank of river affords highway access; rail and unimproved highway access available on north bank. Common labor rates $1.03, skilled from $1.63 to $2.00.

BIDS: Five bids were received on March 20, 1941, for the substructure, ranging from the contract price of $490,765 to $678,465. Bids were opened April 22, 1941, for the superstructure and electrical equipment. The five superstructure bids ran from $1,276,849 (contract) to $1,493,157. Four electrical bids were received, contract for $85,569 has been awarded to Fries Walters Co., Chicago. (Unit prices not shown here as contract is largely for lump sum items, list of bidders, however, is given).

Substructure

LIST OF BIDDERS:

1. FitzSimons & Connell Dredge & Dock Co., Chicago (contract) $490,765
2. MidWest Const. & Asphalt Co., Chicago 508,304
3. Great Lakes Dredge & Dock Co., Chicago 607,985
4. John C. Tully Co., Chicago 669,959
5. N. S. Mackie Co., Chicago 678,465

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove obstructions	L.S.	$6,000.00	$15,000.00	$15,000.00
2. Fences and sheds	L.S.	2,000.00	4,200.00	3,000.00
3. Cofferdams — Erec. river pier trusses	L.S.	140,000.00	156,000.00	207,745.00
4. North dock walls, excl. cement	L.S.	42,000.00	47,000.00	75,000.00
5. General excavation	5,700 c. y.	2.00	2.90	1.25
6. Dredging	17,000 c. y.	.45	.95	.75
7. Remove rock, boulders, masonry	600 c. y.	12.00	11.00	17.00
8. Remove pavements	400 s. y.	1.50	1.30	7.00
9. Std. portland cement	13,000 bbl.	2.50	2.20	2.15
10. Sub piers, excl. of cement	52,000 c. f.	1.30	1.30	1.15
11. Concrete, Class 1 (excl. cement)	6,000 c. y.	14.00	10.60	15.00
12. Sand fill and sand backfill	4,500 c. y.	1.00	.55	1.00
13. Permanent pile clumps	2 ea.	3,200.00	2,800.00	3,600.00
14. Other piles	2,500 l. f.	.35	.28	.45
15. Driving other piles	2,300 l. f.	.35	.38	.25
16. Creo. yellow pine or Douglas fir timbers	8 M bm.	170.00	125.00	250.00
17. Untr. yel. pine or Douglas fir timbers	25 M bm.	80.00	146.00	100.00
18. Concrete catch basins	3 ea.	175.00	108.00	200.00
19. Concrete sewer manholes	1 ea.	175.00	115.00	200.00
20. Granite block pavement	230 s. y.	8.00	3.80	4.00
21. Struct. steel and rubber bumpers	310,000 lb.	.0825	.0715	.08
22. Reinforcement metal	800,000 lb.	.045	.04	.05
23. 24-in. cast iron pipe sewer	3,500 lb.	.12	.054	.15
24. 8-in. cast iron pipe sewer	4,600 lb.	.15	.07	.20
25. Other cast iron	1,000 lb.	.12	.054	.10
26. Wrought iron	2,300 lb.	.40	.30	.50
27. Floor drains with traps	4 ea.	40.00	5.00	50.00
28. Safety treads	300 l. f.	2.00	.82	1.00
29. Steel sheet piling, left in cofferdams	70,000 lb.	.01	.0253	.03
30. Extra length st. sheet piling	25,000 lb.	.065	.029	.04
31. Sub piers — under air pressure	3,000 c. f.	.10	2.00	.35
32. High early strength cement	600 bbl.	3.50	2.60	4.00
33. Heating, ext. mixing of conc	3,000 c. y.	.25	.86	.25
34. Covering and heating conc	2,000 c. y.	.50	.70	.25
35. Mechanic's time	300 hr.	2.25	2.75	2.50
36. Laborer's time	300 hr.	1.50	1.75	1.50

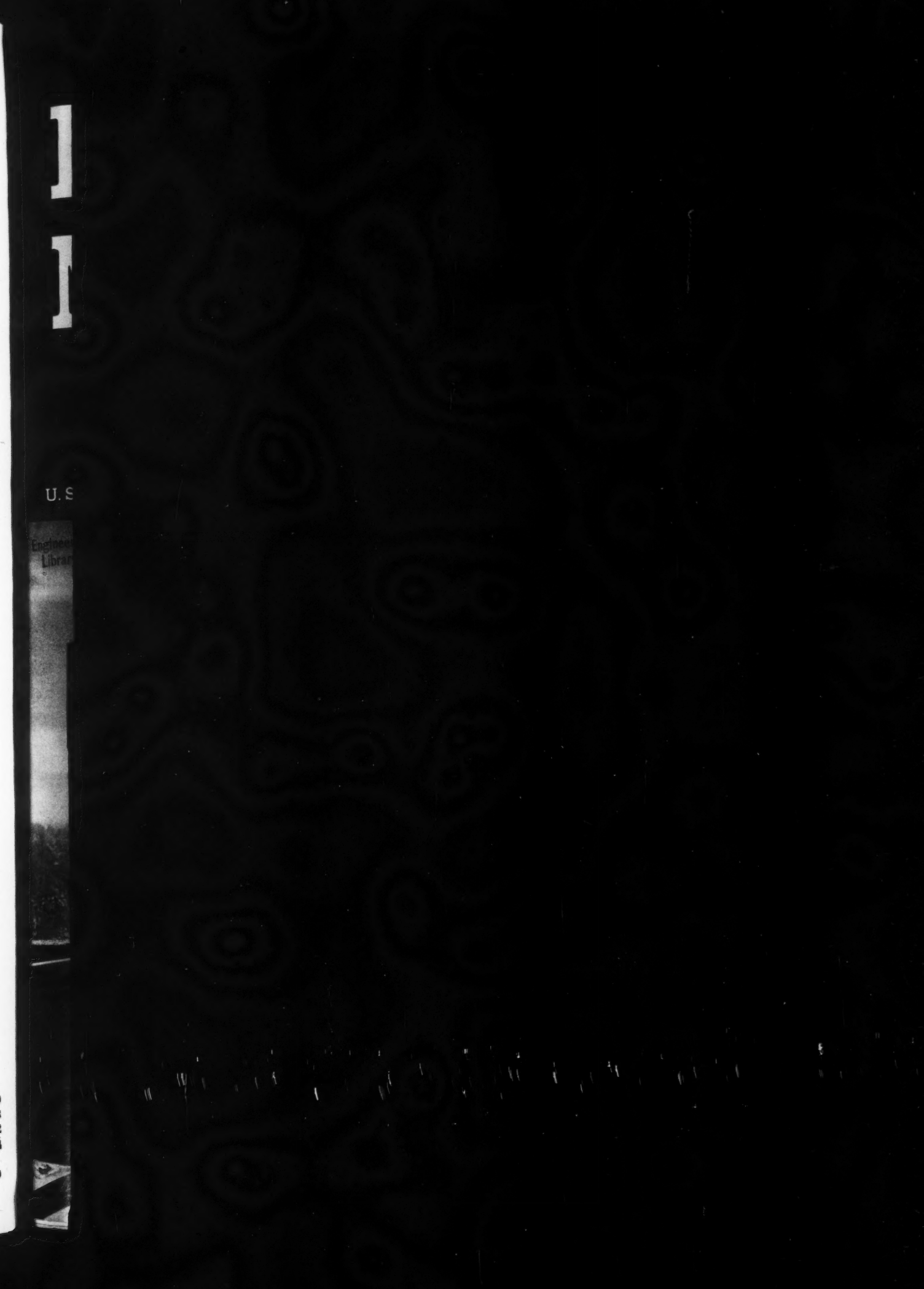
Superstructure

LIST OF BIDDERS:

1. Overland Const. Co., Chicago (contract) $1,276,848
2. Ketler-Elliott Co., Chicago 1,296,283
3. Wm. J. Howard, Inc., Chicago 1,309,024
4. Mt. Vernon Bridge Co., Mt. Vernon, Ill. 1,432,207
5. FitzSimons & Connell Dredge & Dock Co., Chicago 1,493,157

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Fences, sheds and dock protection	L.S.	$3,116.00	$3,434.00	$2,000.00
2. Str. carbon steel and cast iron	4,400,000 lb.	.07892	.082	.0795
3. Struct. silicon steel	1,900,000 lb.	.0895	.091	.09169
4. Cast steel, excluding machinery	240,000 lb.	.239	.249	.248
5. Erect struct. and cast steel	6,540,000 lb.	.0207	.0201	.02279
6. Trans. hand placed salvaged c.i. counterweight	300 ton	10.05	9.07	8.00
7. Trans. hand placed salvaged comp. counterweight blocks	400 ton	8.55	6.25	10.00
8. 145-lb. conc. counterweight	2,600 ton	11.68	8.56	9.30
9. 275-lb. composition counterweight	430 ton	28.18	28.01	28.00
10. Standard portland cement	1,600 bbl.	2.54	3.08	2.30
11. High early strength cement	350 bbl.	3.37	3.84	2.85
12. Admixture No. 1	20,000 lb.	.079	.095	.075
13. Concrete, class 2	1,000 c. y.	36.18	34.41	32.50
14. Steel and conc. rdway.; movable leaves	1,770 s. y.	17.09	17.83	14.00
15. Conc. roadway wearing course	510 s. y.	3.12	3.01	1.90
16. Conc. sidewalk wearing course	480 s. y.	6.03	6.24	3.50
17. Reinforcement metal	105,000 lb.	.059	.064	.06
18. Curb protect., st. steel or cast iron	250 l. f.	2.02	2.00	2.00
19. Sidewalk safety treads	75 l. f.	8.70	7.00	7.95
20. Douglas fir and yellow pine; treated	29 M bm.	157.00	172.76	160.00
21. Redwood; untreated	15 M bm.	256.60	285.34	215.00
22. Asphaltic membrane waterproofing	1,600 s. y.	.82	.92	.80
23. ¾-in. asphalt planking	930 s. y.	2.00	2.12	2.00
24. Block pavement	1,200 s. y.	5.84	6.35	6.25
25. Rolled asphalt pavement	750 s. y.	3.11	3.56	5.65
26. Wacker Dr. sidewalk adjustment	L.S.	3,216.00	3,737.00	3,000.00
27. Remove masonry	5 c. y.	50.20	50.00	20.00
28. Machinery complete	L.S.	251,809.00	257,500.00	276,247.00
29. Electr. ducts and fittings	L.S.	1,392.00	1,414.00	1,571.00
30. Inst. and reconstruct drainage	L.S.	1,206.00	1,519.00	1,620.00
31. Oper. houses; encl. Wacker Dr. stairs; rail	L.S.	109,112.00	111,684.00	109,000.00
32. Plumbing installations	L.S.	1,709.00	1,767.00	2,208.00
33. Heating installations	L.S.	3,655.00	3,777.00	3,835.00
34. Furniture, lockers, equipment	L.S.	352.00	400.00	320.00
35. Hand railing and trap doors	L.S.	19,698.00	20,220.00	20,288.00
36. Field painting; except houses	L.S.	12,060.00	12,120.00	12,269.00
37. Untr. yel. pine or Doug. fir	10 M bm.	122.10	128.50	110.00
38. Wrought iron or Toncan iron	1,000 lb.	.25	.28	.10
39. Common brick	5 M	50.00	52.00	52.00
40. Face brick	2 M	80.00	78.00	97.00
41. Enamel brick	2 M	100.00	160.00	135.00
42. Cut stone	100 c. f.	4.00	4.25	4.00
43. Pre-heating and ext. mixing of concrete	400 c. y.	1.00	1.05	2.00
44. Covering and heating concrete in place	400 c. y.	.50	.60	2.00
45. Mechanic's time	200 hr.	3.15	3.00	3.00
46. Laborer's time	300 hr.	2.00	2.00	2.00

Electrical Work

LIST OF BIDDERS:

1. Fries Walters Co., Chicago (contract) $85,569
2. Harmon Electric Co., Chicago 88,088
3. Divane Brothers, Chicago 88,952
4. Garden City Engineering Co., Chicago 91,154